Epidemiology of Otitis Media: A Community Study

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Abstract: A community study of the incidence of clinically diagnosed otitis media and middle ear effusions was undertaken in the City of Galveston, Texas, based on a random sample of records of patients aged 0–8 years receiving medical care from four major sources during 1975. No overall sex or ethnic differences were observed in association with otitis media. Thirty-five per cent of the sample had at least one episode of otitis media during 1975 and, of these, one-third had two or more episodes, yielding a conservative annual incidence rate of 55.1 per cent for this age group. The overall age-specific incidence pattern indicated the highest rates for the 0–2 year age group (71 to 114 episodes per 100 children) with a steady decline in risk with increasing age. Infants who received an initial diagnosis within the first 12 months of life experienced significantly more episodes of otitis during a two-year period than did children who received an initial diagnosis after one year of age. Seasonal patterns of otitis media were comparable with those reported in other studies. Analysis by birth month of children who experienced repeated episodes of otitis indicated an increased number of children born in the late summer and fall. (*Am J Public Health* 70:593–598, 1980.)

Many authors, including the Committee Report of the Research Conference on Middle Ear Effusions,[1] have emphasized the need for epidemiologic data concerning otitis media and middle ear effusions.[2] In the spring of 1976, a community study to collect such data was conducted in the island community of Galveston, Texas. Information on episodes of otitis media, based on the practicing physicians' criteria for diagnosis, was compiled from records of four major sources of health care in the community. The primary objective of the study was to determine the annual incidence of the disease for children in the entire community.

Galveston is a unique area for this type of investigation in that a large medical facility (the University of Texas Medical Branch) is located on the island and provides most of the medical services received by the triethnic (Anglo-American, Black, and Mexican-American) community of approximately 72,000. At the time of this investigation, two pediatricians in private practice delivered most of the care not provided by the medical center, and the remainder was provided by several general practitioners in the city not affiliated with the University. Galveston Island covers a geographic area of 51 square miles and all of the residents of the island live within the city limits of Galveston. Major access to the mainland is by bridge and a 1.8 mile causeway, or by a 13-minute ferry ride.

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Editor's Note: See also related editorial p. 577, this issue.

Methods

The study population consisted of all children aged 0–8 years in 1975 (i.e., born during the period January 1, 1967 through December 31, 1974) who resided in the city of Galveston and who made at least one medical visit for any reason during 1975 to one of the four major sources of pediatric care in the city. These sources were: 1) a university family medicine clinic; 2) a private pediatric practice; 3) a county comprehensive care clinic located on the island; and 4) a university pediatric clinic.

Children who attended more than one of these four sources of health care in 1975 were identified by computer listing prepared from the census of all children seen at the four locations. This analysis indicated that 205 children visited two or more sources of care during 1975. Individuals who visited multiple sources of care were counted only once to determine the population at risk. This population totaled 4,393 and constituted 77 per cent of the total Galveston population of 5,672 children aged 0–8 years as estimated from 1975 census data. A proportionate age and site-stratified random sample of 1,018 was generated for a comprehensive review of records. Variables of interest were abstracted onto a coding form, and all episodes of otitis media recorded during 1975 were listed by one of the authors (RWB) according to date of diagnosis. Episodes recorded during 1974 for this group were also listed and used in the analysis of recurrent episodes.

A "new episode" of otitis media was considered to have occurred if the record indicated an elapsed period of at least 30 days during which either the patient was not examined, an examination occurred but without notation regarding the status of the ears, or the record designated a previous episode as either resolving or resolved. It is thus possible that

TABLE 1—Ethnic Distribution of Sample of Children Aged 0–8 Years by Source of Care, 1975

Source of Care	Ethnicity			
	Anglo-American % (N = 440)	Black % (N = 399)	Spanish Surname % (N = 167)	Unknown % (N = 12)
1. University Family Medicine Clinic	75.0	15.0	10.0	
2. Private Pediatric Practice	63.9	16.4	16.4	3.3
3. County Comprehensive Care Clinic	23.7	57.6	18.7	
4. University Pediatric Clinic	27.3	55.9	16.8	
TOTAL	43.2	39.2	16.4	1.2

some "recurrent episodes" were exacerbations or continuations of previous episodes that had never completely resolved. An episode of otitis media usually involved a minimum of two physician contacts, an initial and a follow-up visit, although follow-up was not complete in some instances.

All episodes specifically described in the patient's history as "otitis media" were included. Care was taken to exclude external otitis and questionable cases identified only by non-specific clinical indicators such as pulling at the ears or fever. Attempts to categorize individual episodes into purulent or suppurative, serous or non-suppurative, and acute vs chronic, were unsuccessful. Approximately 70 per cent of the episodes diagnosed were not specified in the record as purulent or serous, although most were identified as either bilateral or unilateral. Categorization of diagnoses was not possible due to the lack of specific diagnostic criteria and treatment protocols at the health care sites.

The detailed record review indicated, however, that in all instances the clinical criteria employed for the diagnosis of otitis media represented some combination of the following: infected drum; fluid behind tympanic membrane; loss of mobility with pneumatic otoscopy; and myringotomy with culture. It was not ascertained whether or not all study patients with diagnosed otitis media received antibiotics.

All of the patients in the study were seen in settings staffed by two or more physicians. Ninety-four per cent of the patients were seen by physicians trained or practicing at the University of Texas Medical Branch.

In order to be included in the analysis of recurrent episodes, a child must have been enrolled at one of the four sources of care within one year of his/her birthdate. For the analysis of recurrent episodes, the date of the child's first documented diagnosis of otitis media was obtained whenever possible.

Results

The sex and ethnic composition of the sample of 1,018 children was compatible with 1975 Galveston City Chamber of Commerce census figures, except for a 4 per cent deficit of

TABLE 2—Incidence of Otitis According to Per Cent of Sample Seen in 1975 by Number of Episodes of Otitis, and by Sex, Ethnicity,* and Source of Care

Number of Episodes/ 1975	Sex		Ethnicity			Source of Care†				Total % (N = 1018)
	Male % (N = 521)	Female % (N = 497)	Anglo-American % (N = 440)	Black % (N = 399)	Spanish Surname % (N = 167)	1 % (N = 60)	2 % (N = 371)	3 % (N = 59)	4 % (N = 528)	
0	63.9	66.0	64.1	66.7	63.5	56.7	63.6	88.1	64.2	64.9
1	24.0	22.5	23.6	21.6	25.1	30.0	26.1	5.1	22.5	23.3
2	5.4	7.2	6.6	5.8	7.2	6.7	4.9	5.1	7.4	6.3
3	4.4	2.2	3.0	4.5	1.8	3.3	3.8	—	3.4	3.3
4	1.7	1.4	1.8	1.3	1.8	1.7	1.1	1.7	1.9	1.6
5 or more	0.6	0.6	0.9	0.3	0.6	1.7	0.5	—	0.6	0.6
TOTALS										
1975 Incidence Rate	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
(per 100)**	57.8	52.3	57.5	52.9	55.1	68.3	54.2	22.0	58.0	55.1

*Ethnicity not identified for 12 children in Private Pediatric Practice (Source #2).
†SOURCES: #1—University Family Medicine Clinic, #2—Private Pediatric Practice, #3—County Comprehensive Care Clinic, #4—University Pediatric Clinic.
**Ratio of total number of new episodes to total number of children.

TABLE 3—Per Cent of Sample Seen in 1975 by Number of Episodes of Otitis, Ethnicity, and Incidence of Otitis for Two Sources of Care

Number of Episodes/ 1975	Source of Care: Private Pediatric Practice—#2 Anglo-American % (N = 237)	Black % (N = 61)	Spanish Surname % (N = 61)	Total* % (N = 359)	University Pediatric Clinic—#4 Anglo-American % (N = 144)	Black % (N = 295)	Spanish Surname % (N = 89)	Total* % (N = 528)	Total Anglo-American % (N = 381)	Black % (N = 356)	Spanish Surname % (N = 150)	Total % (N = 887)
0	62.4	67.2	65.6	63.8	68.8	62.7	61.8	64.2	64.8	63.5	63.3	64.0
1	25.7	23.0	27.9	25.6	20.8	23.7	21.3	22.5	23.9	23.6	24.0	23.8
2	5.1	4.9	4.9	5.0	7.6	6.4	10.1	7.4	6.0	6.2	8.0	6.4
3	4.2	4.9	1.6	3.9	0.7	5.1	2.2	3.4	2.9	5.1	2.0	3.6
4	1.7	—	—	1.1	1.4	1.7	3.4	1.9	1.6	1.4	2.0	1.6
5 or more	0.8	—	—	0.6	0.7	0.3	1.1	0.6	.8	.3	.7	.6
TOTALS	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1975 Incidence Rate (per 100)**	59.5	47.5	42.6	54.6	47.2	60.3	67.4	58.0	54.8	58.1	57.3	57.7

*Ethnicity not identified for 12 children in Private Pediatric Practice (Source #2).
**Ratio of total number of new episodes to total number of children.

Spanish surnames in the study sample. The ethnic distribution at the four sources of health care (Table 1) indicated a greater proportion of Anglo-Americans at two of the sources of care and a greater proportion of Blacks at the other two. Less than 12 per cent of the study sample was derived from two of the sources of care: the Family Medicine Clinic with a predominately Anglo-American population (75 per cent), and the County Clinic with a predominately Black population (57.6 per cent). Thirty-five per cent of the study sample had at least one episode of diagnosed otitis media during 1975 although no significant differences in diagnosed episodes by sex and ethnicity were observed (Table 2). In addition, no significant differences in the number of diagnosed episodes per child per year were observed among three of the four sources of health care surveyed, whereas one source, the County Comprehensive Care Clinic, showed a higher percentage of children with no episodes or one episode. This finding may be related to the institution of an Early Periodic Screening, Diagnosis and Treatment (EPSDT) program in 1975, to a higher proportion of well children examined at this clinic, or to differences in the examination procedure resulting in less casefinding. The small number of patients (59) using this source of care and the unavailability of additional data limit a more detailed analysis of this question.

Three hundred fifty-seven (35 per cent) of the sample population were diagnosed as having at least one episode of otitis media in 1975; and of these, 120 (12 per cent) had two or more episodes (Table 2). If we assume that the total population enumerated had experienced the same occurrence rate as the study sample, approximately 2,421 episodes of otitis would have been observed in 1975 in the 4,393 children, assuming only five episodes per child per year in those with more than four episodes. Applying this figure (2,421 episodes) to the entire age 0–8 years population of 5,672, the incidence of otitis media in this age group in 1975 would be

TABLE 4—Age-Specific Incidence* (per 100) of Otitis Media in Sample from Two Major Sources of Care, 1975

Birthyear (age Group)	Private Pediatric Practice No. of Children	Private Pediatric Practice Incidence Rate/100	University Pediatric Clinic No. of Children	University Pediatric Clinic Incidence Rate/100	Total No. of Children	Total Incidence Rate/100
1974 (0-1 yrs)	78	75.6	96	114.6	174	97.1
1973 (1-2 yrs)	58	70.7	78	88.5	136	80.9
1972 (2-3 yrs)	47	44.7	75	50.7	122	48.4
1971 (3-4 yrs)	52	30.8	60	38.3	112	34.8
1970 (4-5 yrs)	47	53.2	69	47.8	116	50.0
1969 (5-6 yrs)	39	71.8	53	26.4	92	45.7
1968 (6-7 yrs)	27	22.2	50	20.0	77	20.8
1967 (7-8 yrs)	23	21.7	47	23.4	70	22.9
TOTALS	371	54.2	528	58.3	899	56.6

*Ratio of total number of new episodes to total number of children.

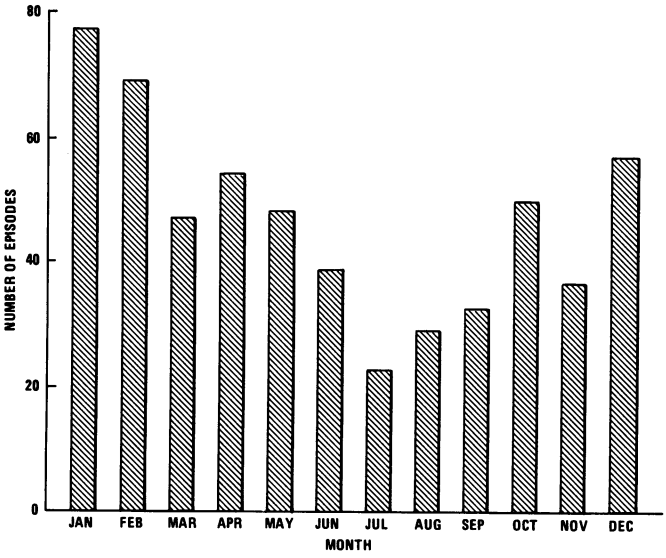

FIGURE 1—Total Number of Episodes of Otitis Media Diagnosed during 1975 in Children Aged 0–8 Years by Month of Diagnosis

42.8 per 100, a conservative estimate in that it also assumes no episodes of otitis among the 1,279 children not enumerated in the study population.

When the ethnic distribution of diagnosed otitis episodes in the two major sources of care (serving 88 per cent of the sample) was examined, the incidence rate was higher for Anglo-Americans in the private pediatric practice than in the University Pediatric Clinic (59.5 per cent vs 47.2 per cent) and higher for Blacks in the University Pediatric Clinic (60.3 per cent vs 47.5 per cent, Table 3). The age-specific incidence rates for the two major sources of care (Table 4) indicated that the younger age groups experienced the highest incidence of otitis media. The steady decline in incidence with increasing age was similar at both sites. Significant differences between the two sources of care in age-specific rates appeared in the age groups 0-1 and 5-6 years. The two other study clinic samples were too small to allow useful comparisons.

The seasonal pattern of otitis media in 1975 indicated that the greatest number of episodes was diagnosed in January and February and the smallest number in July and August (Figure 1). When the data for the 0-2 years age group were compared with those for the 3-8 year age group, this pattern was found in both groups.

Children born prior to 1974 who experienced recurrent episodes of otitis media in the study period 1974-1975 (335 children) were analyzed to evaluate the relationship of recurrent episodes and age at the time of their first diagnosis of otitis. Fourteen per cent of the children who experienced their initial episode of otitis prior to 13 months of age had four or more episodes during this two-year period. By contrast, only five per cent of the children who experienced their initial episode of otitis after 12 months of age had four or more episodes during the same period (Table 5). This difference was statistically significant ($p = .00037$).

A comparison by birth month of children who experienced two or more episodes of otitis media in 1975 indicated that children born in later months of the year (June-December) had the greatest number of recurrent episodes (Table 6). More than 10 per cent of the children experienced recurrent episodes for six of the seven birth months during this period, compared to only one birth month (February) in the period January-May when more than 10 per cent of the children experienced a recurrent episode. Chi-square analysis of episodes during 1975 indicated a significant association ($p = .05$) between the number of recurrent episodes and the birth month. Since the Chi-square goodness of fit technique is inefficient in detecting cyclic trends, a sinusoidal analysis (cosine curve fitted by a weighted least squares analysis for proportions) was done with a modified technique similar to that of Edwards.[3] With this technique, the results remained significant ($p = .01$), indicating a seasonal pattern. This increase in the number of recurrent episodes in children born in later months was also noted when data for 1974 and 1975 were combined. A comparison by birth month of children who experienced only one episode during 1975 did not indicate a seasonal pattern of occurrence of those episodes.

Discussion

In our study we identified 77 per cent of the total population aged 0-8 years in the city. This provided a fairly representative base from which to select the stratified proportionate sample. Individuals not enumerated either sought care from other available sources (local practitioners) or received no care at all.

The occurrence of otitis media in an entire pediatric population is difficult to assess on the basis of reported studies. Relatively few data exist regarding the risk of developing otitis media for the pediatric segment of an entire community. The Report to the Medical Research Council[4] of Great Britain represents the only comparable community study of otitis media. Most epidemiologic data regarding otitis media are derived from single sources of care in selected communities.[5-8] Unless the patient population of the single source of care is representative of the community, results of such a study may not be indicative of the community experience.

Direct comparison of rates and results obtained in this study with other studies utilizing single clinics may not be completely valid. Diagnoses used in the present study had not been based on standardized criteria, and no assumptions were made regarding the type of otitis media on the basis of recorded treatment. This study was therefore similar to the survey of the Medical Research Council[4] in Great Britain in which diagnoses were made without standardized criteria by practicing physicians in several communities.

The community sources of health care surveyed in this study varied considerably with respect to ethnic composition. The differences observed in the occurrence of otitis media by ethnicity within or between the two major sources of care were inconsistent and more suggestive of socioeconomic differences than a true difference in risk associated with ethnicity. Earlier reports[2, 9] which indicate ear pathology as

TABLE 5—Number of Children* Identified by Birthyear, Age at Initial Diagnosed Episode of Otitis Media and Number of Episodes Reported per Child during 1974 and 1975

Birthyear (Age)	Age at Initial Diagnosis (months)											
	≤ 12 Months				> 12 Months				Total			
	Number of Episodes				Number of Episodes				Number of Episodes			
	0	1-3	4+	Total	0	1-3	4+	Total	0	1-3	4+	Total
1973 (1-2)	2	36	16	54	0	22	1	23	2	58	17	77
1972 (2-3)	15	27	4	46	0	22	4	26	15	49	8	72
1971 (3-4)	18	16	3	35	4	11	0	15	22	25	3	50
1970 (4-5)	14	11	3	28	9	8	1	18	23	19	4	46
1969 (5-6)	15	3	2	20	7	12	0	19	22	15	2	39
1968 (6-7)	11	6	0	17	7	8	0	15	18	14	0	32
1967 (7-8)	5	2	0	7	6	5	1	12	11	7	1	19
TOTALS	80	99	28	207	33	88	7	128	113	187	35	335

*Subsample of children who experienced recurrent episodes of otitis media in 1974-75.
$\chi^2 = 15.81$ (2 d.f.), $p = .00037$, comparing number of episodes per child by age at initial diagnosis.

being more prevalent among Whites than Blacks may reflect differences from our study in such elements as duration of episodes of otitis, definitions of ear pathology used, access to care, and case ascertainment.[9] The high rate we observed for all ethnic groups, coupled with availability of care in the city of Galveston, support our finding that ethnicity contributes little to the risk of otitis media.

The minimum annual incidence of 42.8 per 100 estimated for the 0-8 year age group of Galveston during 1975 is substantially higher than the 14 per 100 incidence rate reported in the British community study[4] which presumably employed similar diagnostic criteria. Further, the British report described a lower incidence in the youngest age groups than that observed in the present study. These discrepancies between the two studies may be due to incomplete case ascertainment in the youngest age group in the British community study, as suggested by the authors themselves.[4] On the other hand, the incidence observed for our study sample (55.1 per 100) is comparable to the rate calculated by one of the authors (RWB) from a report of a private practice published by Howie[10]—approximately 30 per 100 for ages 0-6 years.

The overall age-specific incidence pattern obtained in the present study is dissimilar to that presented in several other reports[4, 7, 11, 12] which describe a peak in incidence for children aged 3-6 years. Other reports[6, 9, 13] are in agreement, however with the general trend we observed: highest incidence in the youngest children with a steady decrease in age-specific incidence with increasing age. Some authors have attributed the reported increased incidence for the 4-6 year age group to increased contact with other individuals at school age and this trend is noted in the experience of the private pediatric practice.

Findings reported by Howie[5] regarding otitis "proneness" are supported to some extent by our analysis of the

TABLE 6—Number of Children with Recurrent (2 or more) Episodes of Otitis Media by Age in 1975 and Month of Birth

Age Group 1975 (in Years)	Month of Birth												Children with Recurrent Episodes	Total Children	Per Cent
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC			
7-8	1							2					3	79	(3.8)
6-7													—	88	(—)
5-6		1	1			1	2		3		1	2	11	105	(10.5)
4-5	1	2	1		1		2	1	2		2	3	15	132	(11.4)
3-4		2	2				1		3	1	1		10	127	(7.9)
2-3		1					1		2	2	2	2	10	135	(7.4)
1-2		2			3	3	4	9	1	2	3	3	30	155	(19.4)
0-1	1	4	4	4	1	5	2	6	5	2	4	3	41	197	(20.8)
Total with Recurrent Episodes	3	12	8	4	5	9	12	18	16	7	13	13	120		
Total	69	77	79	87	69	82	102	97	95	83	85	93		1018	
Per Cent	4	16*	10	5	7	11*	12*	19*	17*	8	15*	14*			(11.7)

*Indicates months when more than 10% of children experienced a recurrent episode.

recurrence of otitis media. Howie defined the "otitis-prone" condition as six or more episodes of otitis media in a child before the age of six years. Using this definition, Howie described a significant relationship between "proneness" and age at the time of initial episode. Klein[14] also implicates early onset of otitis as increasing the risk of recurrent episodes. In our study children known to have contracted otitis media prior to their first birthday were more likely to have experienced recurrent episodes (four or more in a two-year period) than children who initially contracted the disease after their first birthday.

In attempting to relate month of birth to number of recurrent episodes of otitis, we found a seasonal pattern, with larger proportions of children who experienced recurrent episodes having been born in the later months of the year (June-December). This seasonal increase in risk by birth month was present only for children who had at least two episodes of otitis in 1975, and the pattern appears consistent across all age groups (Table 6). This finding could be explained by the fact that children born during the summer and early fall achieve the age of six months or older in mid-winter, a high risk period for upper respiratory infections. Prior to age 6 months some protection may be provided by the combination of acquired maternal antibody and limited exposure.

Age, geographic location, age at initial episode of otitis, and month or season of birth may all have some impact on the total number of episodes of otitis media a child experiences. Many practitioners believe that some or all of these factors may affect a child's risk of future episodes.

Closer observation and special clinical management may be indicated for certain children who appear at higher risk of recurrent middle ear infections and complications. Perrin, et al,[15] have suggested that certain high risk children may benefit from prophylactic use of antimicrobial agents. In addition, pneumococcal vaccines may eventually offer another form of protection to the child who is potentially susceptible to otitis media.

This study, utilizing data available in existing medical records, suggests a substantial incidence of otitis media in the preschool aged population and indicates the need for additional, more precise studies of this disease. Prospective studies, using standardized diagnostic criteria, are needed to more fully elucidate the pattern of occurrence of this common pediatric illness.

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ACKNOWLEDGMENTS

This research was supported in part by the Donald A. Rappoport Memorial Fund, Department of Pediatrics, University of Texas Medical Branch, Galveston, Texas. The original version of this paper was presented at the 10th anniversary meeting of the Society for Epidemiologic Research, Seattle, Washington, 1977.

The authors are indebted to Dr. Clayton Eifler and Ms. Lucina Suarez for assistance with the statistical analyses, and to Drs. Sally Robinson and Manon Brenner for their assistance. We would also like to thank Drs. Carlos Bolano and Warren Dodge for their cooperation and support, Ms. Sharon Radovich for her assistance with the massive data collection, and Dr. Philip Nader and Ms. Johanna Price for their critical review of the manuscript.

Grant/Fellowship Proposals for Educational Experiments Invited

The National Fund for Medical Education is seeking applications for innovative grants and fellowships in medical education for 1981. The deadline for project proposals is October 1, 1980.

Current priority is being given to projects that show promise of containing the cost of health care without compromising its quality, or for improving the educational process with particular emphasis on continuing medical education, or management of "information overload" resulting from advanced diagnostic technology.

One-year fellowships are also available for postdoctoral students who plan careers in academic medicine. Deadline for fellowship applications in November 1, 1980. Directions and application forms can be obtained from the office of grants and contracts or directly from the National Fund for Medical Education, 999 Asylum Avenue, Hartford, CT 06105 (203) 278-5070.