

Outcome of short-term hospitalization for children with severe asthma

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This study presents results of a family-centered, short-term residential program in which medical, behavioral, and treatment assessments were provided to the child with severe asthma and the family. After a median stay of 15 days, forty-four consecutively admitted children with severe asthma achieved a 93% reduction in hospital days (median, 7 hospital days for the year before treatment versus median 0 hospital days per patient per year at 20½-month follow-up; $p < 0.001$) and an 81% reduction in emergency care (median, 4 visits for the year previously versus median, 0.4 visits per patient per year at follow-up; $p < 0.01$). There was also a significant reduction in corticosteroid bursts and improvement in FEV₁. Unique to this program was mandatory family participation focusing on the child's and family's adaptation to severe asthma and development of family-specific interventions to promote compliance with the treatment regimen. Child and family functioning was assessed at admission and follow-up. Hospital use at follow-up was greater for children from dysfunctional families. Families demonstrating difficulties in disciplining the child with asthma required more hospital days both before admission and at follow-up. Short-term hospitalization for children with severe asthma is associated with significant improvement in pulmonary morbidity when the family of the child is included in assessment and treatment. (J ALLERGY CLIN IMMUNOL 1992;90:66-75.)

Key words: Childhood asthma, rehabilitation, medical and psychologic assessment, pharmacologic and family treatment

Care for the child with asthma has significantly improved in the past 20 years. More effective inhaled agents, such as cromolyn, β_2 -agonists, corticosteroids, anticholinergics, better delivery systems, nebulizers, and spacers, have all contributed to the lessened morbidity.¹⁻⁶ Despite these improvements, a small subset of children with asthma have persistent symptoms that require emergency care and frequent hospitalization and maintenance with oral corticosteroids, with significant adverse side effects.^{7, 8} A small subset of these children die of their illness.^{9, 10}

The family as the unit of assessment for treatment of severe childhood asthma was first suggested by Peshkin (1930).¹¹ He reported that 23 of 25 children

Abbreviations used

CGAS:	Child global assessment scale
FGAS:	Family global assessment scale
CBCL:	Achenbach child behavior checklist
AIDIARC:	Alfred I. duPont Institute Asthma Rehabilitation Center
PEFR:	Peak expiratory flow rate
NJCIRM:	National Jewish Center for Immunologic and Respiratory Medicine
API:	Asthma Precipitant Interview
APS:	Allergic Potential Scale
FEF ₂₅₋₇₅ :	Forced expiratory flow rate between 25% and 75% of FVC

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with intractable asthma improved when they were away from their homes for periods ranging from 2 months to more than a year. He advocated the concept of "parentectomy," which led to the development of the Children's Asthma Research Institute and Hospital, but it was not clear whether improvement was due to placement in an allergen-free environment or to removal from chronic family stress. In 1969, Purcell et al.¹² reported that, by removing all family mem-

bers except the child from the home, children with asthma with emotional precipitants had less asthma symptoms living with a surrogate parent in their own house than with their own parents. These findings suggested that child-family interactions were a significant factor in persistent asthma.

In the 1970s, family therapists began to develop treatment strategies for families of children with severe asthma and began to ask if physical problems, such as asthma, could be the result of dysfunctional relationships (Lask and Kirk).¹³ Liebman et al.¹⁴ studied seven such children and developed the following strategies: (1) alleviate asthma symptoms by training patients in breathing exercises, (2) identify dysfunctional family relationships (parental-child over protection, child neglect, and marital strife) that precipitate asthma, and (3) intervene with the family to change its structure and function. Family involvement in self-management programs was recognized as fundamental and necessary by the National Institutes of Health in the late 1970s. These institutes supported the development of outpatient educational and behavioral modification strategies¹⁵⁻¹⁷ for children with asthma and for their families.

"Living with Asthma," an example of an effective outpatient educational and behavioral self-management program, was developed to teach children to assist in the management of their asthma.¹⁸ Four aims were listed: patients and families acquire (1) basic knowledge about asthma and its treatment, (2) specific self-management skills (use of peak flow meters, administration of medication, and behavior modification skills to promote compliance with children with asthma), (3) experience in applying their knowledge so as to assist medical personnel (role playing), and (4) demonstrate, over time, an ability to cope with asthma and its challenges. This self-management program was introduced during eight outpatient sessions to encourage repetition, support, and reinforcement.

The AIDIARC¹⁹ was established to deliver care to children with severe asthma and their families. Children admitted to the inpatient program had failed previous outpatient treatment. Medical criteria for admission are unstable asthma, as defined by frequent hospitalization, emergency care, and corticosteroid bursts, corticosteroid dependency, and continuous asthma symptoms. Dysfunctional family interactions that necessitate brief separation of the child from the family include (1) ineffective or absent supervision of medication administration, (2) persistence of smoking at home, and (3) ineffective discipline practices because of breathing maneuvers (yelling and crying) that precipitate asthma. The rationale for short-term inpatient rehabilitation is rapid reduction of asthma

symptoms. This rehabilitation is achieved through (1) appropriate pharmacologic treatment in a setting in which medication compliance is assured and (2) avoidance of allergens and/or irritants at home. Exercise testing and training lead to effective pharmacologic therapy for use after discharge. The absence or lessening of symptoms during the rehabilitation program provides the child and family different perceptions of the "past problem" and new options for future management. Unique to this program is mandatory involvement of the family. This involvement allows for the evaluation of child-family interactions responsible for persistent asthma, such as (1) non-compliance with medication and/or prior environmental recommendations^{20, 21} and (2) psychosomatic asthma in children with significant airway reactivity, precipitated by breathing maneuvers (yelling/crying),^{22, 23} in a controlled, therapeutic setting. From these family-management meetings, specific observations are made by the child, family, and staff that lead to unique strategies for each family. Subsequent outpatient care, if this is required, focuses on compliance with pharmacologic agents and family adaptation to chronic asthma.

At the outset of the development of the AIDIARC, three hypotheses were tested concerning the care of children with severe asthma and their families: (1) that short-term hospitalization with involvement of the family could lead to a lasting reduction in hospitalization, emergency care, use of oral corticosteroids, and improvement in pulmonary functioning, (2) poor psychologic functioning at admission would be associated with greater medical morbidity before admission and at follow-up, and (3) ineffective disciplining of the child with asthma by the family would be associated with greater medical morbidity of the child.

SUBJECTS AND METHODS

Patients admitted to the inpatient program had one or more of the following medical criteria: (1) three or more hospitalizations in the 1 year before admission (45% of subjects), (2) four or more emergency-care visits in the year before admission (67%), (3) four or more corticosteroid bursts in the year before admission (44%), (4) corticosteroid dependence (daily or every other day for 6 or more months in the year before admission (20%), (5) hypoxic seizures with status asthmaticus (5%), (6) respiratory failure (5%), (7) psychologic factors leading to acute asthma symptoms (70%), and (8) more than 30 days of school absences or failure to advance to the next grade level (40%). Families who accepted the program agreed to participate in twice-weekly family sessions, which integrate medical and behavioral recommendations to the individuals responsible for caring for the child. Specific behavioral techniques included role playing of attack management, behavioral contracting,

increased supervision of medication administration, and family therapy (when this was indicated) to redirect dysfunctional efforts into an acceptable and coordinated approach to the management of asthma. Forty-four consecutively admitted children with severe asthma refractory to outpatient treatment participated in the study. Patients were 6 months to 17 years of age (median, 9.2 years) and were hospitalized at AIDIARC for at least 8 days. Institutional review board approval for the protocol and consent form were obtained. Admission to the study began in May 1987, and follow-up care was evaluated through June 1990.

Referring physicians and parents listed all facilities used for medical care during the 2 years before admission to AIDIARC. These data were also recollected every 6 months after discharge. The referring and all other physicians also recorded (1) number of office visits requiring epinephrine or nebulized β_2 -agonists and (2) the use of corticosteroid medications (inhaled and oral). Medical-use information was sought from other medical facilities by requesting admission/discharge/emergency room—visit data for asthma care within the same time periods.

Subject evaluation

On admission, adverse environmental factors, asthma severity, pulmonary-function data, and medications were evaluated. Patients had pulmonary-function testing (lung volumes, spirometry, and PEFs), x-rays (chest and lateral neck), fluoroscopy of the upper airway, computed tomography scan of the sinuses, a pH probe to assess gastroesophageal reflux, and an electrocardiogram.

Laboratory tests were obtained to rule out the following: cystic fibrosis, α_1 -antitrypsin deficiency, tuberculosis, hypersensitivity pneumonitis, adrenal dysfunction secondary to corticosteroid use, and immune dysfunction, cellular and humoral. Allergy sensitivity (skin test and RAST) was identified to pollen, mold, dust mite, animals, and foods. Aspirin and food challenges were performed when they were indicated. Theophylline levels were obtained when this was indicated, including compliance checks during admission.

Patients were administered a standardized battery of psychologic instruments, including the Wechsler Intelligence Scales, the Wide-Range Achievement Test-Revised, the Gordon Diagnostic Screening Battery, the Piers Harris Self-concept Scale, and Pruzanski Child Depression Scale. Parents completed the CBCL²⁵ to assess their perception of their child's behavioral and emotional status. Level of adjustment was also evaluated by the clinicians on separate scales for the child (CGAS)²⁶ and the family (FGAS).²⁷ Follow-up measures of CBCL, CGAS, and FGAS were made 12 to 24 months after discharge.

Family adjustment to asthma was assessed by a variety of instruments, and structured interviews, including the Behavioral Interview for Asthma drawn from the Living with Asthma program by Creer.¹⁸ The results of these questionnaires formed the basis for mandatory biweekly-treatment meetings with the family.

Based on the four sessions with the family, clinicians rated the family on whether or not they demonstrated, by word or deed, problems in disciplining the child with asthma because of concern of provoking an asthma attack. These

four interviews were video taped to observe both the words and the actions of family members. Videotapes were reviewed to identify patients with this problem.

Interventions

Family education. Patients older than 6 years of age and family members received the Airpower educational program.²⁴ Children received daily instruction by nursing and/or respiratory therapy. Family members received four 30-minute sessions during a 2-week period. Instruction included definition of asthma, pathophysiology, pharmacologic treatment, and self-management principles with a PEF meter. Initial assessment questionnaire was compared to after assessment to evaluate comprehension and need for specific review.

Physical therapy evaluated the child's exercise ability with free running, stationary bike, and swimming while the child was receiving a specified pharmacologic therapy. PEFs were monitored before and after exercise challenge to assess the presence of exercise-induced asthma and to determine the maximal interval before β_2 -agonists and cromolyn would need to be readministered for control of exercise-induced asthma. One hour of exercise training was performed twice daily. Parents were asked to attend exercise sessions to observe the child's capabilities and pulmonary function.

Home environmental visits, when these were possible, were undertaken by a team member to assess potential allergen and irritant exposures. Family recommendations concerning removal of known allergens and irritants were then made.

Family meetings were a major intervention in the inpatient rehabilitation program. The content of these brief intensive family-therapy sessions included (1) structured diagnostic behavioral interview, (2) attack-management assessment, and (3) investigation of the reasons why asthma symptoms persisted despite aggressive outpatient management (e.g., under treatment, noncompliance, presence of home environmental allergen or irritant, family maladaptation to illness, ineffective child discipline, or hyperventilation-induced asthma secondary to crying or shouting in response to parental discipline). Assessment of this information led to the development of a comprehensive treatment program.

The outpatient portion permits, if this is required, continued focus on problems recognized during the inpatient phase. Subsequent outpatient treatment includes, at each visit, (1) patient history, including review of home peak flow meter monitoring, number of physician visits or emergency care visits, use of oral corticosteroid medications, and frequency of hospitalization, (2) physical examination, (3) spirometry, (4) drug monitoring, including theophylline levels and total eosinophil counts (if the patient is receiving theophylline or oral corticosteroid), and (5) family therapy when this is indicated.

Statistical analysis

Data analysis of the medical and psychologic variables focused initially on descriptive statistics, including multiple correlations. Admission and follow-up variables were con-

TABLE I. Comparison of admission demographics and medical data of children with severe asthma*

Variables	NJCIRM ²⁷	AIDIARC
No. Pts	103	44
Age (yr)	9-17	6 mo-17 yr
Median (yr)		9.2
	Percent	Percent
M/F	54/46	61/39
Race		
White	91	48
Black	6	46
Hispanic	0	6
Other	3	0
Health insurance		
Commercial	94 (est)	61
Medicaid/none	6	39
Referral source		
Allergists and pulmonologists	NR	77
Primary care	NR	23
Previous long-term admissions	10	5
Adverse environmental factors	75	80
Length of disease >8 yr	68	NR
History of		
Respiratory failure	18	5
Seizures during asthma	17	5
Exercise-induced bronchospasm	92	100
Total No. of hospital days lifetime (median) [†]	NR	17.5 (1-367)
Steroid use in year before admission		
None	19	14
Episodic	50	66
Continuous q.d. or q.o.d.	31	20

Pts, Patients; est, estimated; NR, not reported; q.d., every day; q.o.d., every other day.

*Cared for at the NJCIRM and the AIDIARC.

[†]5th to 95th percentile.

sidered dependent variables and were analyzed as either continuous variables or were categorized into two groups as a function of treatment outcome, measured in terms of episodes of rehospitalization or more than two episodes of emergency care in the year after treatment. Relationships between admission morbidity variables and follow-up variables or psychologic functioning were assessed by Wilcoxon's rank sum. Relationships between follow-up variables and admission or follow-up psychologic functioning were also evaluated with Wilcoxon's rank sum. The nonparametric tests were used because of the small sample size and the lack of normality of the dependent variable distributions.

RESULTS

At hospital admission, patients ranged in age from 6 months to 17 years (median, 9.2 years) (Table I); 61% were male patients, 48% were white, 61% had commercial insurance, and 39% had either Medicaid or no insurance. Seventy-seven percent of the patients were referred by allergists or pulmonologists because

of persistent symptoms. The long-standing nature of pulmonary symptoms is reflected in that the median total number of hospital days lifetime before admission was 17½ days (range, 1 to 376 days). All the patients had a history of exercise-induced bronchospasm. Sixty-six percent of the patients received episodic oral corticosteroids in the year before admission; 20% were receiving daily or alternate-day steroid administration.

Medical and psychosocial status of the patients at admission are presented in Table II; 84% of the patients were receiving theophylline; 100% were receiving β -agonists; 52% were receiving cromolyn; 20% of the patients received daily or alternate-day oral prednisone; and 34% received inhaled corticosteroids. Median FEV₁ on admission was 89%; median FEF₂₅₋₇₅ was 74%; median functional residual capacity was 116%.

Psychologic assessments on admission revealed ev-

TABLE II. Medications, pulmonary function, and psychosocial variables

Variables	NJCIRM % admission	AIDIARC % admission	AIDIARC % follow-up (mean, 20½ mo)
Medications			
Theophylline	94	84	74
β-agonists	100	100	100
Cromolyn	32	52	91
Steroids			
Oral	64	20	27
Inhaled	27	34	82
Pulmonary function (% predicted) (admission median)*			
FEV ₁	112 (43-169)	89 (48-104)	92.5 (69-117)
FEF ₂₅₋₇₅	53 (11-157)	74 (36-132)	71.5 (29-114)
TGV	123 (58-264)	NR	NR
FRC	NR	116 (71-220)	NR
IgE (SDs from age-level mean)	NR	2.4	NR (mean, 18 mo)
Psychosocial variables (follow-up median)*			
CGAS	58 (33-85)	58 (32-85)	72 (32-88)†
FGAS	59 (25-88)	62 (25-87)	70 (36-68)†
CBCL	60 (40-89)	61.5 (41-77)	59 (36-68)‡

TGV, Thoracic gas volume; FRC, functional residual capacity; NR, not reported.

CGAS and FGAS range, 0 to 100; more functional adjustment with higher score; minimum functional score, 71.

CBCL range, 20 to 80; more functional adjustment with lower score; maximum functional score of 69.

*5th to 95th percentile.

† $p < 0.0001$.

‡ $p < 0.05$.

TABLE III. Clinical impact of asthma rehabilitation at AIDIARC annualized

N = 44		Median
Length of stay (day)		
Median		15 (range, 8-52)
Length of follow-up (mo)		
Mean		20.5 (range, 12-35.2)
		Median
Variables	1-yr prior*	Average annualized 20-mo follow-up
Hospital days	7 (1-26)	0 (0-4.2)†
Emergency care visits	4 (0-8)	0.4 (0-3.2)†
Corticosteroid bursts	3 (0-8)	1.8 (0-5.0)‡
At admission		
FEV ₁	89 (48-104)	92.5 (69-117)‡
FEF ₂₅₋₇₅	74 (86-132)	71.5 (29-114)

Mean theophylline level of 32 patients receiving this medication at follow-up (mean, 20.5 mo), 11 µg/ml.

*5th to 95th percentile.

† $p < 0.001$.

‡ $p < 0.01$.

idence of significant disorganization and distress, both for the individual child and the family units. CGAS and FGAS are graded from 0 to 100, with a higher number indicating more functional behavior. Values of ≤ 70 are dysfunctional. The CBCL is graded from 20 to 80; a lower number indicates more functional behavior. Values of 70 or higher are classified as dysfunctional. Median value for CGAS on admission was 58%. Normal range for CGAS was >70 . Thirty patients (77%) had CGAS ≤ 70 . Median value for FGAS on admission was 62. Normal range for FGAS was >70 . Thirty-four families (77%) had FGAS ≤ 70 . Parent ratings of child adjustment, reflected in scores on the CBCL, indicated overall average levels of adjustment (median, 61.5), with 13% of the sample reflecting elevations in the clinical range (total, >70) at the time of admission.

Length of stay at the AIDIARC was 8 to 52 days, with a median of 15 days. Length of outpatient treatment varied from 12 months to 3 years (mean, 20½ months) (Table III). At the time of follow-up, patients were prescribed more medications for use than they were receiving at the time of admission (Table II). The intervention during the AIDIARC hospitalization has been described in detail.¹⁹

TABLE IV. Pulmonary morbidity at **follow-up** in relation to psychosocial functioning of the child with severe asthma (CGAS) and family (FGAS) at **admission**

Admission		Follow-up	Admission	
Dysfunctional children (CGAS ≤ 70 ; N = 30)	Functional children (CGAS > 70 ; N = 9)	Medical morbidity (mean 20.5 mo at follow-up)	Dysfunctional families (FGAS ≤ 70 ; N = 34)	Functional families (FGAS > 70 ; N = 10)
Median*	Median		Median	Median
0 (0-4.8)	0 (0-7)	Hospital days/yr	0 (0-4.8)	0 (0-0) [†]
0.4 (0-4.3)	0 (0-1.7)	Emergency care visits/yr	0.4 (0-4.3)	0 (0-3.2)
2.1 (0.2-5.4)	1.0 (0-3.8)*	Steroid bursts/yr	1.9 (0-5.4)	0.9 (0-3.8)
92.5 (76-117)	92 (68-113)	FEV ₁ %	91.5 (76-113)	103 (68-117)
68.5 (41-114)	73 (29-99)	FEF ₂₅₋₇₅ %	63.5 (41-97)	95.5 (29-130) [†]

*5th to 95th percentile.

[†] $p < 0.05$.

Medical-morbidity outcomes are reported in Table III. Hospital days, emergency care visits, and corticosteroid bursts for the 1 year before admission are compared to those reported during the follow-up period (mean, 20½ months). Median hospital days during the 1-year period before admission to AIDIARC were 7 (1 to 26) hospital days versus 0 (0 to 4.2) hospital days per patient per year at follow-up ($p < 0.001$). Median emergency care visits during the 12-month period before admission were four (0 to 8) visits versus 0.4 (0 to 3.2) emergency care visits per patient per year during the 20½-month follow-up ($p < 0.001$). Median corticosteroid bursts during the 12 months before admission were three bursts per year versus 1.8 (0 to 5) bursts per patient per year at mean follow-up of 20½ months ($p < 0.01$). Median FEV₁ before admission was 89% (48% to 104%) versus 92.5% (69% to 117%) at follow-up (mean, 20½ months) ($p < 0.001$). Median FEF₂₅₋₇₅ before admission was 74% (37% to 132%) versus 71.5% (29% to 114%) at follow-up (mean follow-up, 20½ months). No statistical differences were noted for this variable. Mean theophylline level for the group of 32 patients receiving theophylline at follow-up of 20½ months was 11.0 µg/ml. Of the patients in the sample, 46% received immunotherapy as outpatients.

Psychologic functioning for the children (CGAS), families (FGAS), and parent-reported child behavior problems (CBCL) improved from the time of admission to follow-up (Table II). Median data reviewing the relationship between child and family functioning at admission with follow-up pulmonary morbidity are presented in Table IV. By comparing child and family functioning at admission with pulmonary morbidity at

follow-up (Table IV), dysfunctional children had more steroid bursts, 2.1 (0.2 to 5.4) bursts per year versus one (0 to 3.8) burst per year; $p < 0.05$ at follow-up than functional children. Similarly, children from dysfunctional families, measured at admission, had more hospitalizations 0 (0 to 4.8) hospital days per year versus 0 (0 to 0) hospital days per year; $p < 0.05$ and lower FEF₂₅₋₇₅ at follow-up than functional families, 63.5 (41 to 97) versus 95.5 (29 to 130). There was no statistical difference in medical use before admission when dysfunctional and functional admission CGAS and FGAS were compared.

There was no relationship found between ratings of child (CGAS) and family (FGAS) functioning at follow-up and follow-up medical-morbidity status. Child behavior ratings (CBCL) did not distinguish low or high morbidity groups when ratings were assessed at either admission or follow-up.

Families were evaluated by specific behaviors and attitudes that could lead to, or directly cause, asthma symptoms. One such child-parent interaction was the child's response to parental discipline in which the child's breathing maneuvers (crying, coughing, or hyperventilation) precipitated asthma symptoms. Determination of discipline problem was made during the inpatient evaluation. Thirty-one families had this asthma-provoking interaction. The contribution of discipline problem to pulmonary morbidity before and at follow-up is reviewed in Table V. Children from families with discipline problems had greater total hospital days 25 (4 to 367) versus 12 (1 to 51), $p < 0.05$, and lower FEV₁, 88 (47 to 98) versus 96 (59 to 107), $p < 0.01$ before admission than children without discipline problems. Children from families

TABLE V. Relationship between medical morbidity and family discipline of the child with severe asthma (at admission and follow-up)

	Dysfunctional discipline (N = 31) median*	Functional discipline (N = 13) median
Admission morbidity		
Hospital days lifetime	25 (4-100)	12 (1-51) [†]
Hospital days/1-yr prior	7 (0-29)	7 (1-20)
Emergency care visits/yr	4 (0-10)	4 (0-8)
Steroid bursts/yr	4 (0-9)	2 (0-8)
FEV ₁ %	88 (47-98)	96 (59-107) [‡]
FEF ₂₅₋₇₅ %	72.5 (15-139)	80 (43-151)
IgE (SD from age-level mean)	2.3 (0.9-4.2)	2.1 (0.1-4.2)
Outcome morbidity		
Hospital days/yr	0 (0-4.8)	0 (0-0) [†]
Emergency care visits/yr	0.4 (0-4.3)	0.4 (0-1.7)
Steroid bursts/yr	2.0 (0.4-5.9)	0.5 (0-3.7) [†]
FEV ₁ %	92 (76-117)	95 (68-113)
FEF ₂₅₋₇₅ %	71.5 (41-114)	70 (10-95)

*5th to 95th percentile.

[†]*p* < 0.05.[‡]*p* < 0.01.

with discipline problems had more hospital days per patient per year (0 [0 to 4.8] versus 0 [0 to 0], *p* < 0.05) and had more corticosteroid bursts (2.0 [0.4-5.4] versus 0.5 [0 to 3.7], *p* < 0.05) at follow-up than children from families without discipline problems (Table V).

The relationship between families with discipline problems and psychosocial measures of child, family, and parent-child interactions is listed in Table VI. At the time of admission, CGAS, FGAS, and CBCL scores were significantly impaired for those demonstrating discipline problems compared with scores for those without discipline problems. Patients with discipline problems continued to manifest greater impairment in functioning at follow-up, as reflected in dysfunctional CGAS (68 versus 75, *p* < 0.05), dysfunctional FGAS (66 versus 75; *p* < 0.05), and CBCL (61 versus 49; *p* < 0.05).

There was no statistically significant difference in preadmission hospitalization rate, emergency care, or corticosteroid bursts as a function of the following patient-sample characteristics at admission: smokers at home, gender or race of the patient, insurance classification, or IgE level.

DISCUSSION

This short-term inpatient rehabilitation program (median length of stay, 15 days), combined with out-

TABLE VI. Relationship between psychologic functioning of the child and family in relation to discipline of the child with severe asthma

	Dysfunctional discipline (N = 31) median*	Functional discipline (N = 13) median
Psychologic function		
At admission		
CGAS	53 (35-72)	65 (45-85) [†]
FGAS	58 (35-75)	75 (45-85) [‡]
CBCL	67 (57-77)	54 (41-62) [‡]
At mean 18-mo follow-up		
CGAS	68 (45-80)	75 (55-88) [‡]
FGAS	66 (41-85)	75 (53-86) [‡]
CBCL	61 (50-67)	49 (43-66) [‡]

*5th to 95th percentile.

[†]*p* < 0.01.[‡]*p* < 0.05.

patient follow-up (mean, 20½ months), was successful in reducing subsequent hospitalization by 91% and emergency care 81%. There was also a reduction in the need for corticosteroid bursts and an increase in FEV₁; (Table III). These 44 children with severe asthma, aged 6 months to 17 years (median, 9.2 years, served as their own controls, comparing pre-rehabilitation with postrehabilitation outcomes. To determine the significance of the effectiveness of this program, it is relevant to compare these data with other outcome studies with a similarly effected patient population.

Strunk et al.,²⁸ at the NJCIRM, have published outcome data on 103 children with severe asthma (aged 9 to 17 years) cared for as inpatients between 1983 to 1985. They obtained selected medical data during 1 year before admission, during admission, and 1 year after discharge. The median length of stay was 75 days. Demographic and psychosocial data were collected during the admission. Demographic, medical, and psychosocial data from the NJCIRM and AIDIARC are compared in Tables I and II. From a medical-morbidity comparison, patients at the NJCIRM had a greater incidence of respiratory failure (18%) and seizures with asthma (17%) than patients treated at AIDIARC. However, patients at AIDIARC demonstrated significant prior morbidity in that (1) 77% had failed outpatient subspecialist (allergy/immunology or pulmonary) care, (2) median total number of hospital days lifetime before admission to AIDIARC was 17.5 days, and (3) more patients at AIDIARC were receiving cromolyn (52%) and inhaled corticosteroids (34%) before admission than patients at NJCIRM. The demographic characteristics of

the two centers were different in that NJC patients were older, more racially homogenous (91% white), and had a greater percentage of children with commercial health insurance. Admission psychologic assessment by CGAS, FGAS, and CBCL was quite similar. The NJCIRM reported a 39% reduction in hospital days and 45% reduction in emergency care. Although both programs were successful in reducing hospitalization and emergency care, there were two fundamental differences in the treatment approach. The NJCIRM treated the patient alone with no subsequent outpatient care. AIDIARC integrated inpatient care for the child's asthma with family members' participation and offered outpatient care when this was needed after discharge.

The inpatient treatment program developed at AIDIARC for these children with chronically severe asthma consisted of an integrated educational, behavioral, and family system assessment and intervention. At AIDIARC, the family and the child received educational material focusing on the pathophysiology of asthma, medication actions and side effects, and proper use of the medication and delivery systems. By the end of the hospital stay, both child and family members understood the rationale of the treatment plan.

To reduce subsequent emergency care and unnecessary hospitalization, families participated in attack-management training. Through role playing, staff members identified ineffective practices, and families were provided with specific training for acute asthma episodes. The stepwise process included (1) recognition of degree of depression of lung function via use of mini-Wright peak flow meter, (2) appropriate use of nebulized β_2 -agonists, (3) removal of patient from offending allergen and/or irritants, (4) assignment of specific tasks to each family member to minimize confusion and emphasize relaxation, and (5) the provision of the phone number for a physician(s) to review the clinical situation and consider the possible use of oral corticosteroids and/or antibiotics before the child is observed by the physician in the emergency room or office.

From a behavioral model, the child and family were assessed on the degree of adaptation or maladaptation to the asthma symptoms. The child received standardized psychologic tests while the parents completed standardized and asthma-specific instruments describing the impact of asthma on the family. The Behavioral Interview for Asthma, developed by Creer,¹⁸ outlines specific behaviors and responses by the child and family members that were associated with persistent asthma. A family interview was undertaken to meet with all family members to describe their interface with persistent asthma. By reviewing

the allergic medical profile (atopic sensitivity, pharmacologic and immunotherapy, and environmental exclusion complicating medical factors), the family questionnaires, psychologic test results, and family interviews, an integrated treatment plan was formulated that was specific and unique to each family. It became possible to hypothesize specific child/family behaviors responsible for specific asthma symptoms. These hypotheses included noncompliance with pharmacologic treatment plan, under treatment, persistence of home environmental allergens and/or irritants, and child/parent maladaptation to severe asthma. Maladaptation may include (1) parental over protectiveness or rejection, (2) breathing maneuvers secondary to crying in response to parental discipline; this may lead to ineffective parenting, since parents may not want to provoke asthma and prefer to yield to the child's requests, (3) peripheral or little involvement of one spouse or parent, and (4) sibling neglect and resentment. By recognizing and modifying the above patterns in relation to specific behaviors that precipitate or exacerbate asthma, the family receives assistance in medical management that requires change in attitudes and behaviors, specifically about a medical issue. This approach is in distinction to prior studies of children with severe asthma and their families in which psychiatrists or psychologists also treated dysfunctional relationships that are not directly related to asthma symptoms.^{13, 14, 32} In those studies, psychiatrists or psychologists were the primary therapists. In the current study, the treatment team includes both the allergist/immunologist and the psychologist to focus on medically relevant issues.

To test the second hypothesis that lower psychologic functioning at admission is associated with greater pulmonary morbidity before admission and at follow-up, we compared admission CGAS, FGAS, and CBCL to medical outcomes before and after rehabilitation. Strunk et al.,²⁸ using the same psychologic instruments, did not find any relationship between admission psychologic functioning of the child and family and medical use before admission. They did, however, find a moderate relationship between lower CGAS and FGAS at admission and increased medical use at 1-year follow-up. In the study at AIDIARC, low psychologic functioning of the child (CGAS, <70) and family (FGAS, <70) at admission was related to increased pulmonary morbidity at outcome. Children with lower psychologic functioning had more corticosteroid bursts (2.1 patient per year versus 1; $p < 0.05$) at 20-month mean follow-up than higher functioning children (Table IV). Children from families with low psychologic function, determined at admission, had more hospital days and lower FEF₂₅₋₇₅ at follow-up than children from functional

families. There was no statistical relationship between (1) CGAS and FGAS at admission and medical morbidity before admission, (2) CGAS and FGAS at follow-up and medical morbidity at follow-up, and (3) CBCL at admission or follow-up with medical morbidity before admission or at follow-up. However, it should be mentioned that, as a group, psychologic functioning of both children and families improved from admission to follow-up (Table II). This finding is most likely related to significant reduction in symptoms. Although data in Table IV support the hypothesis that dysfunctional children and families have less improvement than functional families, both functional and dysfunctional groups demonstrated significant reductions in pulmonary morbidity. Because of the limited sample size ($N = 44$), we were unable to test the second hypothesis with more rigorous analyses. The psychologic instruments used had limitations, and the development or application of more discriminating instruments would be required for a more definitive conclusion.

The third hypothesis tested was the relationship of child-parent interactions that directly produced asthma symptoms and their effect of increasing pulmonary morbidity. The specific behavior evaluated was the response of the child with asthma to discipline by yelling or crying and thus inducing bronchospasm. Seventy percent of the families in this study, when they were confronted with this behavior, were reluctant to discipline the child for fear of provoking an asthma attack. These data presented in Table V support the hypothesis that parent-child interactions directly related to asthma are associated with greater pulmonary morbidity. This finding is demonstrated by families with dysfunctional discipline who have children with history of more hospital days lifetime before admission to AIDIARC and lower lung function (FEV_1) at admission. This theory is also supported by the observation that children from families with dysfunctional discipline have more hospital days per year and corticosteroid bursts at follow-up. If psychologic function is examined (child, family, and parent-reported child behavior) in relation to dysfunctional discipline of the family, a stronger statistical relationship is found (Table VI). The 31 families with dysfunctional discipline had more impaired scores of CGAS, FGAS, and CBCL on admission, as well as at follow-up, than those families without discipline problems. This suggests that effective parenting of the child with severe asthma and psychologic functioning of the child and family are directly related, as reported earlier by one of the authors (A. G. W.)²² It should be noted that, although families without discipline problems had greater improvement in pulmonary morbidity and psychologic functioning, families with discipline problems made significant gains as well.

A similar analysis of children with asthma was performed by Kagan and Weiss²⁹ who administered two questionnaires, the API³⁰ and the APS, to a group of children with asthma. The APS assesses medical factors related to asthma, whereas the API assesses what psychologic stimuli precipitate a patient's asthma attacks. These authors had predicted an inverse relationship between the API and APS but did not find it when the index of emotional precipitants included only responses, such as worry, anger, being upset and excited, but excluded responses such as crying or laughing. When crying was added to the index of emotional precipitants, however, the prediction by Kagan and Weiss²⁹ proved to be clearly supported. By including specific behaviors that can effect the production of asthma symptoms, we, as well as Kagan and Weiss,²⁹ can more meaningfully assess their relationship to pulmonary morbidity and psychologic function. By identifying families with a dysfunctional relationship that precipitates asthma, specific interventions, both pharmacologic and psychologic, can be used to block this asthma-related behavior.^{23, 31}

In summary, short-term family-centered hospitalization for severe childhood asthma helps decrease asthma symptoms in two ways. Appropriate medication selection and testing its efficacy with exercise training promotes optimal lung function and performance. Involvement of the family in the intensive short-term inpatient rehabilitation program and in outpatient follow-up provides the family insight into how the family has been stressed by the illness and how the family can better adapt to become more functional in managing the illness and in communicating among themselves.

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