

Characterizing Avoidable Transfer Admissions in Infants Hospitalized for Bronchiolitis

Tehnaz P. Boyle, MD, PhD,^a Charles G. Macias, MD, MPH,^b Susan Wu, MD,^c Sara Holmstrom, MD,^{d,e} Larissa L. Truschel, MD, MPH,^d Janice A. Espinola, MPH,^f Ashley F. Sullivan, MS, MPH,^f Carlos A. Camargo Jr, MD, DrPH^f

ABSTRACT

OBJECTIVES: The appropriateness of interfacility transfer admissions for bronchiolitis to pediatric centers is uncertain. We characterized avoidable transfer admissions for bronchiolitis. We hypothesized that a higher proportion of hospitalized infants transferred from a community emergency department (ED) or hospital (transfer admission) would be discharged within 48 hours with little or no intervention, compared with direct admissions from an enrolling ED (nontransfer admission).

METHODS: We analyzed a 17-center, prospective infant cohort (age <1 year) hospitalized for bronchiolitis (2011–2014). An avoidable transfer admission (primary outcome) was hospitalization for <48 hours without an intervention for severe illness in which a pediatric specialist could be beneficial (oxygen, advanced airway management, life support). Parenteral fluids and routine medications were excluded. We compared admissions by patient, ED, inpatient, and transferring hospital characteristics to identify factors associated with avoidable transfer admissions. Multivariable logistic regression was used to identify predictors of avoidable transfer admission.

RESULTS: Among 1007 infants, 558 (55%) were nontransfer admissions, 164 (16%) were transfer admissions, and 204 (20%) were referrals from clinics; 81 (8%) were missing referral type. Significantly fewer transferred infants were hospitalized for <48 hours with little or no intervention (40 of 164; 24% [95% confidence interval 18%–32%]) than nontransferred infants (199 of 558; 36% [95% confidence interval 32%–40%]; $P = .007$). Avoidable transfer admissions were more likely to be children of color, have nonprivate insurance, receive fewer ED interventions, and originate from small EDs. A multivariable model revealed that minority race and/or ethnicity, normal oxygenation, and small ED transfers increased odds of avoidable transfer admission.

CONCLUSIONS: Although most transferred infants hospitalized for bronchiolitis required interventions for severe illness, 1 in 4 admissions were potentially avoidable.

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Address correspondence to Tehnaz P. Boyle, MD, PhD, Boston Medical Center, 801 Albany St, Room 4025, Boston, MA 02119. E-mail: tehnaz.boyle@bmc.org

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^aBoston Medical Center, Boston, Massachusetts; ^bRainbow Babies and Children's Hospital, Cleveland, Ohio; ^cChildren's Hospital Los Angeles, Los Angeles, California; ^dBoston Children's Hospital, Boston, Massachusetts; ^eAnne & Robert H. Lurie Children's Hospital of Chicago, Chicago, Illinois; and ^fMassachusetts General Hospital, Boston, Massachusetts

Most children in the United States receive emergency care in low-volume emergency departments (EDs).^{1,2} Children who are critically ill have better outcomes in dedicated, high-volume pediatric centers.^{3,4} In the last decade, pediatric emergency care regionalization has increased interfacility transfers and admissions to pediatric centers.^{1,5–8} Referring providers cite the need for a pediatric subspecialist and anticipated treatment exceeding the scope of the local hospital as the most common reasons for transferring children.⁹ However, ~40% of transferred children are discharged within 48 hours with little or no further intervention, suggesting that many admissions with a transfer admission source may be unnecessary (avoidable).^{10–13} Avoidable transfer admissions are costly and disruptive, particularly for rural families.^{14,15}

Improving identification of children likely to benefit from transfer admission for high-volume conditions, such as acute bronchiolitis, could improve health care resource use.^{15,16} In previous studies, authors used administrative claims data to examine the appropriateness of patient transfers to pediatric EDs rather than hospitalizations with a transfer admission source and used diagnostic groupings, which limits evaluation of individual conditions.^{10,13,15,17–19} In 1 study, authors found that patient-level factors, including white race, nonprivate insurance, severe illness, and rural residence, predicted hospitalization with a transfer admission source but could not examine the appropriateness of these admissions without linked patient records.¹⁶ This has limited the precision of estimating avoidable transfer admissions among bronchiolitis hospitalizations.

Our objective was to describe the distribution of avoidable transfer admissions within a multicenter, multi-year, prospective cohort of infants hospitalized for bronchiolitis. This data set contains linked patient records from referring and receiving facilities to permit refined assessment of transfer need. We hypothesized that a higher proportion of hospitalized infants transferred for

admission from an outside ED or hospital would be discharged within 48 hours with little or no intervention when compared with nontransferred admissions.

METHODS

Study Design and Population

We performed a secondary analysis of a multicenter prospective cohort study of children hospitalized for bronchiolitis during 3 consecutive winter seasons (November 1 to April 30; 2011–2014). This study was part of the 35th Multicenter Airway Research Collaboration (MARC-35), an Emergency Medicine Network program (see Supplemental Information). The study setting, data collection methods, and measured variables were reported previously.²⁰ Seventeen sites participated across 14 US states.

Inclusion criteria were age <1 year, an attending physician diagnosis of bronchiolitis as defined by the American Academy of Pediatrics,²¹ and availability of parent or guardian informed consent. Patients were enrolled within 24 hours of admission to a study hospital. Exclusion criteria were previous enrollment; transfer to a study hospital >24 hours after the original hospitalization; known cardiopulmonary disease, immunodeficiency, or immunosuppression; and gestational age <32 weeks. Cohort children were treated at physician discretion. The study was approved by institutional review boards at each participating hospital.

Transfer Admission Identification

We used a previously published method to identify transfer admissions.¹⁶ First, we classified hospitalized children on the basis of whether they presented directly to an enrolling study ED or were referred for admission by another health care facility (referral). Referral facility types included primary care clinics, urgent care facilities, another ED or hospital, or other clinic. We defined nontransfer admissions as when the index patient evaluation resulting in hospitalization occurred at an enrolling study ED in a pediatric center and transfer admissions as when the index patient evaluation occurred at a referring acute

care facility type (another ED or hospital). To limit bias in outcome assessment, we included index EDs that lack the capability to hospitalize children because we could not assign transfer admission appropriateness a priori. To limit the impact of transport modality and institutional variation in transfer admission processes, transfer admissions included patients transferred directly to a receiving hospital inpatient unit and those transferred to a receiving study ED and subsequently admitted. Infants transferred from a referring facility who were directly discharged from a receiving study ED were not enrolled in the parent study and were therefore unavailable for analysis. We also excluded admissions in which the referring facility type was a clinic or urgent care facility from the primary analysis because they lack hospitalization capability and may be subject to cognitive bias toward admission for ED physicians at enrolling study sites. This subgroup was described and analyzed separately.

Outcome Measures

Next, we categorized transfer admissions as potentially avoidable or unavoidable. An avoidable transfer admission (primary outcome) was defined as a patient discharged in <48 hours without an intervention for severe illness when pediatric specialty care could be beneficial. In previous studies on avoidable transfer admissions, researchers have used 24-^{10,15} and 48-hour¹⁹ lengths of stay (LOSs) when defining brief admissions. We prioritized need for interventions over duration of hospitalization because LOS for bronchiolitis exhibits institutional variability²² and may be influenced by factors unrelated to illness severity.²³ Therefore, we chose an LOS <48 hours as the duration of brief admissions to maximize inclusion of transfer admissions but still adhere to the Centers for Medicare and Medicaid Services definition of observation status.²⁴ However, we also examined a restricted version using an LOS <24 hours to avoid overestimating the primary outcome prevalence. Because we were interested in the appropriateness of transfer admissions to pediatric centers, we differentiated interventions that could reasonably necessitate transfer for a

pediatric specialist or higher level of care not available at the transferring facility from those that could be performed without transfer. We included the following inpatient interventions as indicators of need for a pediatric specialist or higher level of care: supplemental oxygen, advanced airway interventions (high-flow nasal cannula, continuous positive airway pressure, and tracheal intubation), and other life-support measures (eg, extracorporeal membrane oxygenation). Numerous studies have revealed that oxygen saturation <92% predicts escalated care.^{25–28} Because bronchiolitis is a dynamic disease, we reasoned that need for supplemental oxygen was an early marker of severe illness that could reasonably necessitate transfer to a pediatric center. However, parenteral fluids and routine medications (eg, antipyretics, albuterol) were excluded as interventions that could be performed locally without transfer.

Data Collection

As described previously, patient demographics, medical history, and presenting illness details were collected by using structured interview.²⁰ A manual chart review was performed at the Emergency Medicine Network Coordinating Center to abstract clinical data from the index ED encounter and hospitalization at enrolling study sites. Site investigators were queried about missing and discrepant data.

Three study investigators (T.P.B., S.H., and L.L.T.) performed an additional chart review on records from referring facilities, the enrolling study ED and inpatient hospital course (to abstract triage vital signs), physician examination findings, medical interventions, and diagnostic tests performed in each location. All referring facility encounters and transfer documentation were also reviewed for patient mode of arrival (ambulance, private vehicle, or other), triage Emergency Severity Index score, reason for transfer (no pediatric capability, pediatric subspecialist needed, anticipated need for higher level of care, parent or guardian preference, or other), mode of transfer (ambulance, private vehicle, or other), and location of receipt at the receiving facility (pediatric ED, floor admission, or ICU admission). Medical

intervention data included medications (inhaled β -agonists, nebulized hypertonic saline, corticosteroids, and antibiotics); parenteral fluids, supplemental oxygen therapy, advanced airway management, and life-support measures; and locations in referring and receiving facilities where each intervention occurred. Data were collected and stored in a secure data form by using the Web-based Research Electronic Data Capture (REDCap) application hosted by Partners HealthCare Research Computing Enterprise Research Infrastructure and Services.²⁹

We obtained supplemental data for hospital characteristics and matched referring facility information to the 2011 American Hospital Association (AHA) and National Emergency Department Inventory–USA (NEDI-USA) databases.^{30,31} Hospital characteristics included total ED visit volume (small: <20 000; medium: 20 000–39 999; large: \geq 40 000) and number of hospital beds. We categorized transferring hospitals by pediatric capability, as defined previously: (1) no pediatric capability (no pediatric ED, inpatient, or intensive care available), (2) some pediatric capability (pediatric ED care only, pediatric inpatient care only, or pediatric ED and inpatient care only), and (3) high pediatric capability (pediatric ED, inpatient, and intensive care available).¹⁹ We also identified whether the transferring facility was a rural hospital or a critical-access hospital and whether it was an academic ED (ie, the primary or only site of an ED residency program). We additionally examined each receiving (enrolling) hospital by size (number of beds), as identified in the AHA database, and ED volume, hospital geographic region, and teaching hospital status (member of the Council of Teaching Hospitals), as identified in the NEDI-USA database. We estimated the distance in miles between referring and receiving facilities using Google Maps software by inputting each facility address and recording the distance associated with the shortest transport time.

Data Analysis

All analyses were performed by using Stata 14.2 (Stata Corp, College Station, TX). We

compared transfer and nontransfer admissions by clinical presentation, patient, and ED and inpatient encounter characteristics. We report descriptive statistics presenting proportions with 95% confidence intervals (CIs) or medians with interquartile ranges (IQRs). We tested the association between patient and hospital characteristics by transfer status using χ^2 , Fisher's exact, or Kruskal-Wallis tests as appropriate. For hospital-level analysis, we aggregated transferring hospitals that originated \geq 1 avoidable transfer admission or no avoidable transfer admissions (ie, unavoidable transfer admissions only) and receiving (enrolling) hospitals that received \geq 1 avoidable transfer admissions or no avoidable transfer admissions. Multivariable logistic regression was used to identify predictors of avoidable transfer admission. All models were adjusted for potential clustering within the enrolling site. Two-tailed $P < .05$ was considered statistically significant.

RESULTS

The study cohort is depicted in Fig 1. Of the 1007 (99%) hospitalized infants with available records, 449 (45%) had outside facility referrals, whereas 558 (55%) were admitted from an enrolling study ED (nontransfer admission). Among referrals, 164 of 449 (37%) were transferred from an outside ED or hospital (transfer admission). Patients referred from clinics or urgent care facilities (204 of 449; 45%) or missing a referral facility type (81 of 449; 18%) were excluded from the primary analysis. Therefore, transfer admissions represented 16% (95% CI 14%–19%) of the 1007 hospitalizations in the analytical cohort.

Among the 164 transfer admissions, 66 (40%) had an LOS <48 hours, whereas 17 (10%) had an LOS <24 hours. Regardless of LOS, 53 (32%) transfer admissions did not require any supplemental oxygen, advanced airway management, or life support. Twenty-two (13%) transfer admissions required no intervention at all (including parenteral fluids and medications), among which 21 (95%) had an LOS <48 hours and 6 (27%) had an LOS <24 hours. The proportion of transferred infants hospitalized for

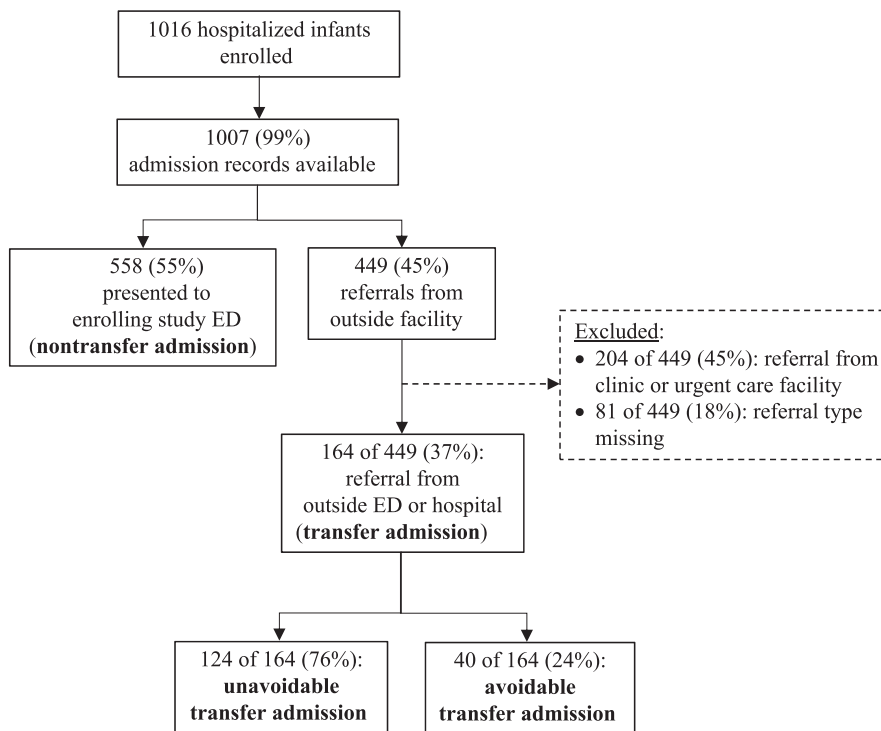


FIGURE 1 Study population.

<48 hours with little or no intervention (40 of 164; 24% [95% CI 18%–32%]) was significantly lower than the proportion of nontransferred infants (199 of 558; 36% [95% CI 32%–40%]; $P = .007$). Among referrals from clinics or urgent care facilities, 63 of 204 (31%; 95% CI 25%–38%) infants were hospitalized for <48 hours with little or no intervention. When restricting the primary outcome to an LOS <24 hours in the sensitivity analysis, we identified 14 transferred infants with little or no intervention (9%; 95% CI 5%–14%), which was still lower than the proportion with the restricted outcome among nontransferred infants (15% [95% CI 12%–18%]; $P = .046$). Among referrals from clinics or urgent care facilities, 28 of 204 (14%; 95% CI 10%–19%) infants were hospitalized for <24 hours with little or no intervention.

We compared patient, initial ED encounter, and inpatient hospitalization characteristics among admissions classified as avoidable transfers, unavoidable transfers, and nontransfers (Table 1). Although nearly half (49%) the transfer admissions were non-

Hispanic white children, avoidable transfer admissions were more likely to be of minority race and/or ethnicity. Overall, transfer admissions were younger, sicker, and received more ED interventions than nontransfer admissions. However, avoidable transfer admissions were less likely to have triage vital signs indicating severe disease or receive oxygen in the initial ED encounter than unavoidable transfer admissions and nontransfer admissions.

Next, we analyzed avoidable and unavoidable transfer admissions for differences in reasons for interfacility transfer, distance from the receiving facility, mode of transfer, and the initial location of receipt at the pediatric center. Among all transfer admissions, reasons for interfacility transfer included anticipated need for a higher level of care (71%), lack of pediatric capability (42%), anticipated need for a pediatric subspecialist (10%), and parent or guardian preference (4%). Lack of pediatric capability (65% vs 35%; $P = .001$) and parent or guardian preference (10% vs 2%; $P = .03$) were more common among avoidable transfers, whereas anticipated

need for a higher level of care was more common among unavoidable transfers (79% vs 48%; $P < .001$).

The median transfer distance from the receiving facility was 21 miles (IQR 13–39). Most (67%) transfer admissions originated within 30 miles from the receiving facility; 90% were transported by ambulance. Among 164 transfer admissions, 33 (20%) were received at an enrolling study ED before hospitalization, whereas 131 (80%) were directly admitted to an inpatient unit (floor or ICU). We found no statistically significant differences in median transfer distance, mode of interfacility transport, or initial location of receipt between avoidable and unavoidable transfer admissions.

Because hospital-level factors previously predicted avoidable ED transfers,¹⁹ we compared transferring hospital characteristics (Table 2) and receiving (enrolling) hospital characteristics to identify potential differences between avoidable and unavoidable transfer admissions. The 164 transfer admissions originated from 105 unique referring hospitals. Among the referring hospitals, 15 (14%) had a small ED, 32 (30%) a medium ED, and 56 (53%) a large ED. Small EDs trended toward association with avoidable transfer admissions. Of the 10 avoidable transfer admissions requiring parenteral fluids as the primary intervention, only 1 originated from a hospital with no pediatric capability, whereas 8 came from hospitals with some pediatric capability, and 1 could not be matched to the AHA database. Twelve (71%) of the 17 receiving hospitals received at least 1 avoidable transfer admission and 140 (85%) transfer admissions. There was no association between receiving (enrolling) hospital size, geographic region, or teaching hospital status and avoidable transfer admissions.

In the multivariable analysis of infants transferred and hospitalized for bronchiolitis, minority race and/or ethnicity, normal oxygenation in the referring ED encounter before transfer, and transfers originating from small EDs were associated with higher odds of avoidable transfer admissions (Table 3). Including insurance

TABLE 1 Comparison of Avoidable Transfer, Unavoidable Transfer, and Nontransfer Admissions Among Infants Hospitalized for Bronchiolitis

	Transfer Admissions (n = 164)		Nontransfer Admissions (n = 558)	P ^a
	Avoidable (n = 40)	Unavoidable (n = 124)		
Patient characteristics				
Age, mo, median (IQR)	2.9 (1.5–4.9)	2.7 (1.4–5.2)	3.4 (1.8–6.1)	.02
Male sex, n (%)	23 (58)	71 (57)	330 (59)	.92
Race and/or ethnicity, n (%)				<.001
Non-Hispanic white	11 (28)	70 (56)	180 (32)	
Non-Hispanic black	15 (38)	26 (21)	154 (28)	
Hispanic	10 (25)	25 (20)	205 (37)	
Other	4 (10)	3 (2)	19 (3)	
Insurance type, n (%)				.04
Nonprivate	28 (70)	69 (56)	375 (67)	
Private	12 (30)	55 (44)	183 (33)	
History of prematurity, n (%)	7 (18)	19 (15)	110 (20)	.52
Initial ED encounter				
Arrival by ambulance, n (%)	8 (20)	24 (20)	29 (5)	<.001
Median ESI score, median (IQR)	3 (3–3)	3 (2–3)	2 (2–3)	.01
Initial vital signs, n (%)				
RR >45	12 (3%)	65 (54)	356 (64)	.02
Lowest Sp _o ₂ <94%	10 (26)	76 (64)	245 (44)	<.001
Initial physical examination, n (%)				
Retractions				
No or mild retractions	24 (71)	55 (47)	306 (56)	
Moderate or severe retractions	7 (21)	49 (42)	192 (35)	
Not documented	3 (9)	12 (10)	45 (8)	
Wheeze	17 (50)	64 (55)	252 (46)	.21
ED interventions, n (%)				
Nebulized albuterol	22 (55)	85 (69)	263 (47)	<.001
Parenteral fluids	18 (45)	77 (62)	334 (60)	.15
Supplemental oxygen	7 (18)	91 (73)	277 (50)	<.001
Noninvasive ventilation	0 (0)	15 (12)	53 (10)	.04
Invasive ventilation	0 (0)	7 (6)	12 (2)	.08
Other critical care measures	0 (0)	0 (0)	1 (0.2)	.99
Inpatient hospitalization				
Inpatient interventions, n (%)				
Nebulized albuterol	9 (23)	45 (36)	145 (26)	.051
Parenteral fluids	10 (25)	89 (72)	282 (51)	<.001
Supplemental oxygen ^b	0 (0)	111 (90)	297 (53)	
Advanced airway management ^b	0 (0)	42 (34)	99 (18)	
Other critical care measures ^b	0 (0)	3 (2)	4 (1)	
ICU admission, n (%)	0 (0)	41 (33)	69 (12)	
LOS, d, median (IQR) ^b	1 (1–2)	3 (2–6)	2 (1–3)	
LOS <24 h, n (%) ^b	14 (35)	3 (2)	100 (18)	
LOS <48 h, n (%) ^b	40 (100)	26 (21)	300 (54)	

ESI, Emergency Severity Index; RR, respiratory rate; Sp_o₂, pulse oxygen saturation; —, not applicable.

^a P values refer to comparisons between avoidable transfer, unavoidable transfer, and nontransfer admissions.

^b Variables were part of the primary outcome definition.

type did not substantively change the results.

DISCUSSION

In this large multicenter prospective cohort, 16% of hospitalized infants with bronchiolitis were transferred for admission from another ED or hospital. Three-quarters of transfer admissions were infants hospitalized for ≥48 hours who required interventions warranting care in a pediatric center. Still, 1 in 4 transferred infants had brief admissions with little or no intervention that were potentially avoidable, representing an opportunity to improve health care use.

In this study, we improve the precision of the estimated proportion of avoidable transfer admissions for acute bronchiolitis using linked patient records to assess transfer admission appropriateness. In a 2012 administrative database analysis, researchers estimated that 18% of patients transferred for bronchiolitis to pediatric EDs were discharged or admitted for <24 hours.¹⁰ However, the study authors lacked data on clinical events at referring hospitals that inform transfer decisions, used administrative codes and claims data at receiving facilities to categorize transfer appropriateness to EDs, and did not evaluate direct transfer admissions to inpatient units. In another recent study, authors examined the appropriateness of transfer admissions but use of diagnostic groupings and the single-center design limited generalizability of findings.¹³

Contrary to our hypothesis, we found significantly fewer brief admissions with little or no intervention among transferred infants compared with nontransferred ones. Evidence suggests that triaging ED physicians at pediatric centers selectively admit transferred infants who are sicker while discharging others.¹⁰ Records for transferred infants discharged by receiving study EDs were unavailable because only hospitalized patients were enrolled, so avoidable transfers referred for admission may be underestimated. In a previous study, authors estimated that 8% of transferred infants with bronchiolitis were discharged from pediatric EDs.¹⁰ Infants who were less sick could have been transferred to acute

TABLE 2 Transferring Hospital Characteristics for Avoidable and Unavoidable Transfer Admissions (*N* = 105 Hospitals)

Transferring Hospital Characteristics	Avoidable Transfer Admission (<i>n</i> = 26), <i>n</i> (%)	Unavoidable Transfer Admission (<i>n</i> = 79), <i>n</i> (%)	<i>P</i>
Small ED (volume <20 000) ^a			.16
Yes	6 (23)	9 (11)	
No	19 (73)	69 (87)	
Missing or unmatched	1 (4)	1 (1)	
No. beds ^b			.52
<100	5 (19)	14 (18)	
100–250	9 (35)	32 (41)	
>250	9 (35)	30 (38)	
Missing or unmatched	3 (12)	3 (4)	
Pediatric capability ^b			.64
No pediatric capability	8 (31)	18 (23)	
Some pediatric capability	11 (42)	41 (52)	
High pediatric capability	0 (0)	3 (4)	
Missing or unmatched	7 (27)	17 (22)	
Rural location ^a			.62
Nonrural	24 (92)	73 (92)	
Rural	1 (4)	5 (6)	
Missing or unmatched	1 (4)	1 (1)	
Critical-access hospital ^a			.64
Yes	1 (4)	6 (8)	
No	24 (92)	72 (91)	
Missing or unmatched	1 (4)	1 (1)	
Academic ED ^a			.69
Yes	0 (0)	2 (3)	
No	25 (96)	76 (96)	
Missing or unmatched	1 (4)	1 (1)	

^a One hundred three hospitals (155 infants) matched to the 2011 NEDI-USA database.²⁷

^b Ninety-nine hospitals (141 infants) matched to the 2011 AHA database.²⁸

We and others found that referring hospitals in large metropolitan areas with small- to medium-volume EDs may be important targets for such interventions.¹⁹ More research is needed to optimize telemedicine to overcome barriers to adoption and use for pediatric emergency care.

Patient-level factors were strong predictors of avoidable transfer admissions. In previous studies, authors identified age, respiratory rate, and oxygen saturation among predictors of hospitalization.^{37–39} We that found mild presenting illness and normal oxygenation increased odds of an avoidable transfer admission. Triage oxygen saturation <90% was the strongest predictor of advanced airway support in 1 study of infants presenting to EDs with bronchiolitis.²⁸ This study suggested that infants with normal oxygenation stratified as low risk for escalated care but still requiring hospitalization could be observed in community hospitals. Our data indicate that this could represent up to 25% of bronchiolitis transfer admissions to pediatric centers. We encourage future studies to validate this risk stratification score and determine its effect on transfer efficiency.

Our results also extend reported racial disparities in interfacility transfer practices in children and adults.^{16,40} Previous studies revealed that white patients have higher odds of transfer admission than African American or Hispanic patients. Although white children accounted for nearly half the transfer admissions, children of color and/or of other ethnicities constituted three-quarters of avoidable ones. Although geographic clustering of minority families near urban teaching hospitals (like the enrolling study sites) could account for some of the observed variation in the odds of transfer admission, our findings raise concern about the differential impact of race and/or ethnicity on transfer and admission practices. Previously, we found no significant differences across racial and/or ethnic groups for inpatient bronchiolitis management, suggesting that disparate care during hospitalization is a less likely explanation.⁴¹ Other social determinants of health (eg, access to health care services)

care facilities other than the study sites, which would also underestimate avoidable transfer admissions. We observed a surprisingly high rate of brief hospitalizations with little or no intervention in nontransferred infants admitted from enrolling study EDs. A recent international study similarly revealed that 30% of bronchiolitis admissions from pediatric EDs received no evidence-based therapies, including parenteral fluids, oxygen, and airway support.³² These data suggest the ED clinicians generally lack accurate means to predict which infants ultimately require escalated care. Decision rules that identify infants at low risk of clinical deterioration^{28,33} could reduce unnecessary hospitalization and interfacility transfers.

However, these tools are underdeveloped and would need widespread adoption to decrease health care overuse.

In this study, most transfer admissions bypassed the receiving pediatric ED, where pediatric emergency physicians could triage transfer admissions with questionable need.¹³ Pediatric expert teleconsultation supporting referring clinicians before initiating the transfer admission may ultimately be more effective.^{34,35} This strategy could help retain infants who require hospitalization for feeding difficulties or milder illness locally within hospital systems lacking pediatric capability. However, pediatric telemedicine implementation and use in US EDs is low.³⁶

TABLE 3 Multivariable Logistic Regression Predicting Avoidable Transfer Admissions ($n = 40$) Among Infants Transferred and Hospitalized for Bronchiolitis ($n = 164$)

Predictor	Model 1			Model 2 ^a		
	OR	95% CI	<i>P</i>	OR	95% CI	<i>P</i>
Minority race and/or ethnicity	4.10	1.93–8.68	<.001	2.75	1.18–6.40	.02
Insurance type						
Nonprivate	1.00	Reference	—	—	—	—
Private	1.69	0.69–4.15	.25	—	—	—
RR ≤45	2.20	0.99–4.92	.05	2.27	0.94–5.51	.07
Lowest Sp _o ₂ ≥94%	4.43	1.85–10.57	.001	4.68	1.62–13.54	.004
Small ED (volume <20 000)	—	—	—	5.18	1.05–25.55	.04

OR, odds ratio; RR, respiratory rate; Sp_o₂, pulse oxygen saturation. —, not applicable.

^a Adding small ED (volume <20 000) and removing insurance type from the original model.

that could influence transfer admission decisions were not comprehensively evaluated. Future studies are warranted to elucidate whether disparities in transfer admissions occur at patient, provider, hospital, or geographic levels.

This study has potential limitations. First, bronchiolitis transfer admissions in this cohort were twice the expected estimate from the Kids' Inpatient Database (8%).¹⁶ Referral and admission practices at participating study centers may differ from those of the national sample, with greater practice variability. Second, we chose hospitalization for <48 hours to define avoidable admissions for consistency with previous work.¹⁹ Although this could overestimate the primary outcome, our sensitivity analysis (focused on hospitalizations <24 hours) is consistent with a previous report.¹⁰ Third, the enrollment strategy could have missed some infants discharged within 24 hours. However, we anticipate this would affect transferred and nontransferred groups equally, so it is unlikely to alter observed intergroup differences. Fourth, because we were interested in the appropriateness of transfer admissions to pediatric centers, we excluded interventions, such as parenteral fluids, that may warrant hospitalization but not necessarily transfer to a referral center. A similar strategy was used to differentiate between procedures requiring transfer and procedures with the potential to be performed locally¹⁹ and to identify infants who were seriously ill and warranted pediatric specialist care.²⁸ However, this

could have contributed to the observed higher proportion of nontransferred infants meeting the primary outcome definition. Additionally, some infants who met criteria for an avoidable transfer admission might have originated from facilities unable to board infants needing hydration and thus could have required transfer. Our results suggest that this represents only a small proportion of avoidable transfer admissions. Fifth, we were likely underpowered to determine if receiving or referring hospital characteristics, such as pediatric capability, were associated with avoidable transfer admissions. Finally, we acknowledge that the decision to transfer a child is complex and multifactorial. Despite linked records, referring provider characteristics that could influence transfer decisions (eg, training, pediatric experience) were unavailable. Although we attempted to abstract primary reasons for transfer admission, this was variably documented and may be subject to assessment bias.

CONCLUSIONS

Although most transferred infants hospitalized with bronchiolitis in this multicenter prospective cohort were seriously ill, 1 in 4 had a potentially avoidable transfer admission. Children with mild illness who do not require supplemental oxygen at ED presentation may not require transfer to a pediatric center and could be managed with local hospitalization. Children of minority race and/or ethnicity had increased odds of

avoidable transfer admission, although the basis for this disparity is unclear and warrants further investigation. As pediatric emergency care continues to regionalize, understanding the drivers of avoidable interfacility transfer admissions for leading conditions of pediatric hospitalization could improve health care resource use. Future research is needed to develop and test clinical and systems-based interventions to support retention of children with milder illness within their communities.

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