

Racial and Ethnic Differences in Subspecialty Service Use by Children With Autism



WHAT'S KNOWN ON THIS SUBJECT: Racial and ethnic differences exist in age at diagnosis and early access to mental and behavioral health services among children with autism spectrum disorders (ASDs). ASDs are also associated with increased rates of other medical comorbidities that may require specialty care.



WHAT THIS STUDY ADDS: Significant racial and ethnic differences in use of specialty care and specialty procedures exist among children with documented ASD.

abstract

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OBJECTIVE: To describe racial differences in use of specialty care among children with autism spectrum disorder.

METHODS: We identified patients ages 2 to 21 years with an *International Classification of Diseases, Ninth Revision* code of autism (299.0) seen from 2000 to 2011 at a major academic health center by using a research patient data repository and determined rates of specialty provider visits and procedures by race. We then used logistic regression to determine the associations of rates of subspecialty visits and procedures with race and ethnicity, controlling for gender, age, and payer type.

RESULTS: We identified 3615 patients (2935 white, 243 Hispanic, 188 African American, and 249 other). The most striking differences were in use of gastroenterology (GI)/nutrition services. Nonwhite children were less likely to use GI/nutrition specialty providers (African American, odds ratio = 0.32 [95th percentile confidence interval: 0.18–0.55]; Hispanic, 0.32 [0.20–0.51]; other, 0.56 [0.34–0.92]) as well as neurology (African American, 0.52 [0.33–0.83]; Hispanic, 0.40 [0.27–0.59]) and psychiatry/psychology (African American, 0.44 [0.27–0.72]; Hispanic, 0.60 [0.41–0.88]; other, 0.62 [0.38–0.99]). Nonwhite children were less likely to have had GI studies: colonoscopy (African American, 0.23 [0.10–0.53]; Hispanic, 0.26 [0.14–0.50]), endoscopy (African American, 0.31 [0.16–0.58]; Hispanic, 0.27 [0.16–0.46]; other, 0.53 [0.31–0.90]), and stool studies (African American, 0.49 [0.30–0.91]). Hispanic children had lower rates of neurologic and other testing: EEG (Hispanic, 0.53 [0.35–0.78]), brain MRI (African American, 0.37 [0.22–0.63]; Hispanic, 0.62 [0.42–0.90]), sleep study (Hispanic, 0.18 [0.04–0.76]), and neuropsychiatric testing (Hispanic, 0.55 [0.32–0.96]).

CONCLUSIONS: We found racial and ethnic differences among children diagnosed with autism in use of care and procedures. Possible explanations for these findings include differences in presentation, referral rates, or referral follow through. *Pediatrics* 2013;132:94–100

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KEY WORDS

racial disparity, autism, access, diagnosis, specialty care

ABBREVIATIONS

ADHD—attention-deficit/hyperactivity disorder

ASD—autism spectrum disorder

CT—computed tomography

GI—gastroenterology

ICD-9—*International Classification of Diseases, Ninth Revision*

OR—odds ratio

RPDR—Research Patient Database Repository

Dr Broder-Fingert conceptualized and designed the study, coordinated and performed data collection, drafted the initial article, and critically reviewed the article; Ms Shui designed the data collection instruments, carried out the final analyses, assisted in study design, and reviewed and revised the article; Mr Pulcini assisted in conceptualization, collected primary data, and reviewed and revised the article; Mr Kurowski carried out the initial analyses and reviewed and revised the article; Dr Perrin assisted in study design and conceptualization and critically reviewed the article; and all authors approved the final article as submitted.

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Autism spectrum disorders (ASDs) are a group of neurodevelopmental disorders characterized by impairments in social interaction, communication, and restricted behaviors, interests, and activities.¹ A number of studies indicate that children with ASD have increased rates of other comorbidities such as seizure disorders, sleep disorders, attention-deficit/hyperactivity disorder (ADHD), anxiety, and gastrointestinal complications.^{2,3} Although several studies demonstrate racial and ethnic differences with respect to age of diagnosis and access to early intervention services among children with ASD,^{4,5} no studies assess racial and ethnic differences in use of subspecialty care or medical procedures.

Previous work has examined access to mental health services or services in general for children with ASD. Mandell et al⁴ found that among Medicaid-insured children with ASD, white children received a diagnosis significantly earlier than did African American children, and in turn received critical mental health services earlier. In the largest study to date, Kogan et al⁶ found that, compared with parents of white children, those of non-Hispanic black children with ASD were more likely to report delayed or forgone care, have no usual source of care, no personal physician or nurse, have difficulty receiving care, or lack ≥ 1 component of family-centered care. This study did not delineate which components were deficient in the study population.

Reported comorbidities in children with ASD include psychiatric, neurologic, and gastrointestinal. Among psychiatric comorbidities, rates of ADHD, anxiety disorder, oppositional defiant disorder, and obsessive compulsive disorder are reported at close to 30% in most studies.^{7,8} Parents of children and adolescents with ASD report sleep problems at rates ranging from 40% to 80%.⁹ Reports of gastrointestinal issues range

from 17% to 85%,¹⁰ and 5% to 38% of children with autism have coexisting epilepsy.¹¹

Given these existing data on racial and ethnic differences in diagnosis and care for children with ASD, along with the increasing recognition of medical comorbidities associated with ASD, we sought to determine if racial and ethnic differences exist in use of specialty care and procedures in a large population of children and adolescents with ASD, while controlling for age, gender, and payer type.

METHODS

We compared use of subspecialty providers and procedures for patients with autism seen at a major academic medical center by race and ethnicity.

Sample

Patients for the cohort were identified through the Partners HealthCare System Research Patient Database Repository (RPDR). The RPDR is an extensive administrative database that contains over 2.5 million patients and 550 million records from patient encounters and is described in detail elsewhere.¹² In short, the RPDR gathers data from various hospital systems (inpatient, outpatient, and emergency visits) and stores it in one place. The database includes demographic information (including race, ethnicity, insurance type, and address), all diagnoses listed for each visit, location of the visit (specific clinic name or inpatient unit), medications, procedures, and billing codes. We initially identified all patients ages 2 to 21 years at Massachusetts General Hospital or its affiliate health centers who received care between January 1, 2000, and January 11, 2011, with an *International Classification of Diseases, Ninth Revision* (ICD-9) diagnosis of autism (299.0). We chose to include only 299.0 (autism) and not 299.8 (Asperger) or 299.9

(pervasive developmental disorder-not otherwise specified) as autism is a more stable diagnosis and less likely to change over time (ie, to another neurodevelopmental condition). Inclusion criteria included the following: (1) between age 2 and 21 years at the time of clinical encounter and (2) a code of 299.0 at any encounter. We then randomly selected 300 charts to review to confirm the accuracy of the autism diagnosis. A single investigator reviewed all 300 charts and found $>90\%$ of patients coded with 299.0 had documented ASD in their medical record. Ninety-three percent of patients had 2 or more encounters, whereas the other 7% only appear once in the data set.

Our 2 main areas of interest were use of subspecialty care and use of procedures. In both cases, we chose services that could reflect comorbid conditions associated with ASD.

Use of Subspecialty Care

Each clinical encounter was coded with the patient's medical record number and the name of the clinical site visited. We limited subspecialty disciplines to those most associated with comorbid conditions among children with ASD (gastroenterology [GI]/nutrition, neurology, and psychiatry/psychology). We categorized clinical sites by these groupings and then determined the number of children who had any visits to each subspecialty group for use in analyses.

Subspecialty Procedures

Clinical encounters in which a patient underwent any procedure were identified by ICD-9 and *Current Procedural Terminology* codes. We included procedures commonly associated with the 3 clinical subspecialties noted earlier and related comorbidities. One individual reviewed all procedures in these areas of interest and coded them

into 5 clinical categories (GI, seizure, sleep, psychosocial, and learning disability), with 12 specific procedures (Table 1). Procedures included the following: pH probe, stool studies, abdominal ultrasound, colonoscopy, endoscopy, EEG, head computed tomography (CT) scan, MRI-brain, sleep study, psychiatric evaluation, neuropsychiatric testing, and developmental screening. We then determined the number of individual children who underwent each procedure in each category for analyses.

Demographic Characteristics

Our primary independent variable was race/ethnicity. We used race/ethnicity as included in the database, based on parent report at time of patient registration. We categorized race/ethnicity as African American, white, other, and Hispanic. Our database only allows patients to report 1 value for race/ethnicity. Therefore, patients cannot identify as both “white” and “Hispanic” but must choose only 1. Age in months and years was coded at each visit as a continuous variable. Gender was coded dichotomously. We categorized payer type in 2 ways for the purpose of analysis. First, we used payer type at the most recent clinical encounter. Given that only 15 of identified patients were uninsured, we collapsed uninsured and public insurance into 1 analysis group. We speculate that the low rates of uninsured reflect that a diagnosis of ASD allows low-income

patients access to public services including health insurance through Medicaid. Therefore, we categorized the encounters as public insurance/no insurance and private insurance. Then, since racial and ethnic minorities are also more likely to change or lose insurance over time, we created a separate variable (switched insurance) in our model to adjust for a change of insurance during the study period. Any change in insurance type (from private to public or public to private) during the 11-year study period was included in this variable. We coded this dichotomously.

Analysis

We initially determined the number of children who had subspecialty visits and procedures and then determined their rates by race/ethnicity. We then used logistic regression to determine the associations of rates of children with subspecialty visits and procedures with race and ethnicity, controlling for gender, age, payer type at most recent visit, and whether they switched insurance type during the study period. Odds ratios and 95% confidence intervals are reported. Missing data were handled via list-wise deletion. Analysis was done by using SAS 9.2 (SAS Institute, Inc, Cary, NC).

RESULTS

We identified 3615 eligible children and adolescents seen between January 1,

2000, and January 11, 2011 (Table 2). The majority of children were white (81.2%) and boys (79.6%), with only 5% African American and 7% Hispanic. More children had private insurance at their most recent visit (44.9%) than public insurance (20.8%). Approximately one-third of the sample lacked information on insurance. Thirteen percent of patients changed insurance type (between public or private) over the 11-year study period.

Subspecialty Visits

Of the 3615 children with ASD, 1557 had subspecialty care visits (13 441 total visits) to the clinics included for analyses over the 11-year study period (Tables 2 and 3). Among African American children, 29.8% had subspecialty visits, whereas 36.9% of white children had such visits (Table 2). Table 3 indicates particularly high differences for GI visits. After adjusting for age, gender, and insurance type by logistic regression, African American and Hispanic children had significantly lower use of subspecialty care in the following areas: GI/nutrition (African American, odds ratio [OR] = 0.32; Hispanic, 0.32; other, 0.56), neurology (African American, 0.52; Hispanic, 0.40), and psychiatry/psychology (African American, 0.44; Hispanic, 0.60; other, 0.62) (Tables 4 and 5).

Subspecialty Procedures

We also evaluated use of select procedures by race; 2218 children had procedures identified within the 5 main categories for a total of 7078 procedures (Table 3). Here, patterns varied substantially. After adjusting for age, gender, and insurance type, nonwhite children were significantly less likely to access specific procedures than white children (Table 5). African American and Hispanic children had less use of GI studies, specifically stool studies (African American, OR = 0.49), colonoscopy

TABLE 1 Common Specialty and Procedure Use in Children With ASD

Comorbid Conditions	Subspecialties Involved	Potential Medical Procedures
Gastrointestinal disorders Abdominal pain Reflux Constipation	GI/nutrition	Laboratory: pH probe; stool studies Radiology: Abdominal ultrasound Procedures: Colonoscopy; endoscopy
Seizure disorders	Neurology	Laboratory: EEG Radiology: CT scan-head; MRI-brain
Sleep disorders	Neurology	Sleep study
ADHD anxiety	Psychiatry/psychology	Psychiatric evaluation
Learning disability	Psychiatry/psychology	Neuropsychology testing; developmental testing

TABLE 2 Patient Demographics and Subspecialty Use for Study Sample (Children Ages 2 to 21 Diagnosed With ASD)

	<i>n</i>	%	Any Visit ^a (%)	Any Procedure ^a (%)
Race/ethnicity				
White	2935	81.2	1083 (36.9)	1815 (61.8)
African American	188	5.2	56 (29.8)	97 (51.6)
Hispanic	243	6.7	89 (36.6)	158 (65.0)
Other	249	6.9	83 (33.3)	148 (59.4)
Gender				
Boy	2879	79.6	1031 (35.8)	1750 (60.8)
Girl	736	20.4	280 (38.0)	468 (63.6)
Insurance				
Private	1624	44.9	916 (56.4)	1250 (77.0)
Public	752	20.8	385 (51.2)	573 (76.2)
Uninsured	15	0.42	8 (53.3)	11 (73.3)
Missing	1224	33.9	2 (0.16)	384 (31.4)
Switched	457	12.6	322 (70.5)	402 (88.0)

^a Includes only visits or procedures included in Table 1.

TABLE 3 Number of Patients With Subspecialty Visits and Procedures by Race/Ethnicity

Subspecialty Visit	White (<i>n</i> = 2935), <i>n</i> (%)	African American, (<i>n</i> = 188) <i>n</i> (%)	Hispanic (<i>n</i> = 243), <i>n</i> (%)	Other (<i>n</i> = 249), <i>n</i> (%)
GI/nutrition	405 (13.8)	17 (9.0)	24 (9.9)	23 (9.2)
Neurology	470 (16.0)	29 (15.4)	38 (15.6)	43 (17.3)
Psychology/psychiatry	531 (18.1)	29 (15.4)	54 (22.2)	32 (12.9)
Procedure				
GI/nutrition				
pH probe	39 (1.3)	1 (0.5)	1 (0.4)	1 (0.4)
Stool studies	286 (9.8)	12 (6.4)	41 (16.9)	18 (7.2)
Abdominal ultrasound	107 (3.7)	6 (3.2)	19 (7.8)	5 (2.0)
Colonoscopy	407 (13.9)	8 (4.3)	14 (5.8)	26 (10.4)
Endoscopy	533 (18.2)	18 (9.6)	21 (8.6)	32 (12.9)
Neurology				
EEG	533 (18.2)	34 (18.1)	50 (20.6)	48 (19.3)
CT scan-head	64 (2.2)	4 (2.1)	15 (6.2)	3 (2.0)
MRI-brain	486 (16.6)	21 (11.2)	47 (19.3)	44 (17.7)
Sleep study	88 (3.0)	2 (1.1)	2 (0.8)	7 (2.8)
Psychology/psychiatry				
Psychiatric evaluation	761 (25.9)	39 (20.7)	58 (23.9)	61 (24.5)
Neuropsychiatry testing	484 (16.5)	21 (11.2)	31 (12.8)	41 (16.5)
Developmental testing	103 (3.5)	14 (7.5)	43 (17.7)	11 (4.4)

TABLE 4 Rates of Subspecialty Visits Per Child Among Children With ASD by Race/Ethnicity

Subspecialty Visit	White, OR (95% CI)	African American, OR (95% CI)	Hispanic, OR (95% CI)	Other, OR (95% CI)
GI/nutrition	Ref	0.32 (0.18–0.55) ^a	0.32 (0.20–0.51) ^a	0.56 (0.34–0.92) ^a
Neurology	Ref	0.52 (0.33–0.83) ^a	0.40 (0.27–0.59) ^a	0.84 (0.55–1.28)
Psychology/psychiatry	Ref	0.44 (0.27–0.72) ^a	0.60 (0.41–0.88) ^a	0.62 (0.38–0.99) ^a

CI, confidence interval.

^a *P* < .05. All logistic regression models are adjusted for gender, age at visit, and insurance.

(African American, 0.23; Hispanic, 0.26), and endoscopy (African American, 0.31; Hispanic, 0.27; other, 0.53). Hispanic children had lower use of neurologic studies: EEG (Hispanic, 0.53), brain MRI (African American, 0.37; Hispanic, 0.62),

sleep study (Hispanic, 0.18), as well as neuropsychiatric testing (Hispanic, 0.55).

DISCUSSION

In a population of pediatric patients with ASD, we found significant racial

and ethnic differences in use of subspecialty visits and procedures. To our knowledge, this is the first study to address these differences in subspecialty care for children with ASD. Use of subspecialty care was significantly different in GI/nutrition, neurology, and psychiatry/psychology. Use of procedures also differed significantly, with differences in GI studies among African American and Hispanic children (endoscopy, colonoscopy, and stool studies), and neuropsychiatric studies among Hispanic children (EEG, brain MRI, sleep studies, and neuropsychiatric testing).

Racial differences in use of care exist for many pediatric conditions.¹³ Studies of the National Survey of Children's Health revealed that minority children were more likely to lack a usual source of care, have unmet medical and dental needs, experience transportation barriers to care, have problems getting specialty care, and lack mental health care.¹⁴ Minority children with neurodevelopmental or mental health conditions fare particularly poorly compared with their white counterparts. Multiple studies demonstrate decreased access to mental health services for nonwhite children.^{15,16} For example, although African American children are more likely to exhibit symptoms of ADHD and depression, they are less likely to receive a diagnosis of ADHD or to use mental health services than white children.¹⁶ African American and Asian/Pacific Islander children are nearly twice to 5 times as likely as white children to report no mental health care in the past 12 months.¹⁴

A few studies address racial and ethnic differences specifically for ASD. In 2002, Mandell et al¹⁴ found that in a group of Medicaid-enrolled patients, African American children were diagnosed with ASD 1.5 years later than white children. The same study revealed

TABLE 5 Rates of Subspecialty Procedures Per Child Among Children With ASD by Race/Ethnicity

Subspecialty	White, OR (95% CI)	African American, OR (95% CI)	Hispanic, OR (95% CI)	Other, OR (95% CI)
GI/nutrition				
pH probe	Ref	0.42 (0.06–3.20)	0.26 (0.04–1.99)	0.43 (0.06–3.19)
Stool studies	Ref	0.49 (0.30–0.91) ^a	1.01 (0.66–1.54)	0.73 (0.42–1.28)
Colonoscopy	Ref	0.23 (0.10–0.53) ^a	0.26 (0.14–0.50) ^a	0.68 (0.39–1.18)
Endoscopy	Ref	0.31 (0.16–0.58) ^a	0.27 (0.16–0.46) ^a	0.53 (0.31–0.90) ^a
Abdominal ultrasound	Ref	0.70 (0.27–1.80)	1.25 (0.68–2.31)	0.40 (0.12–1.30)
Neurology				
EEG	Ref	0.65 (0.41–1.03)	0.53 (0.35–0.78) ^a	0.98 (0.66–1.47)
CT scan-head	Ref	0.76 (0.26–2.17)	1.52 (0.78–2.94)	1.06 (0.41–2.73)
MRI-brain	Ref	0.37 (0.22–0.63) ^a	0.62 (0.42–0.90) ^a	0.99 (0.66–1.47)
Sleep study	Ref	0.15 (0.02–1.11)	0.18 (0.04–0.76) ^a	0.93 (0.39–2.21)
Psychology/psychiatry				
Psychiatric evaluation	Ref	0.74 (0.44–1.30)	0.98 (0.66–1.46)	0.92 (0.56–1.51)
Neuropsychiatric testing	Ref	0.80 (0.44–1.45)	0.55 (0.32–0.96) ^a	1.05 (0.61–1.78)
Developmental testing	Ref	1.47 (0.75–2.87)	3.48 (2.20–5.51) ^a	0.61 (0.21–1.72)

CI, confidence interval.

^a $P < .05$. All logistic regression models are adjusted for gender, age at visit, and insurance.

that African American children were significantly more likely to carry an alternate diagnosis before a documented ASD. The authors speculate that the apparent disparity in time of diagnosis may reflect a lack of regular pediatric care, differences in expectations about treatment and services, or differences in presentation, although data to distinguish among these explanations are limited.⁴ A more recent study exploring severity of autism among children revealed that non-Hispanic white children were more likely to receive an autism diagnosis at the mild and moderate level of severity, whereas non-Hispanic black children were more likely to receive the most severe diagnosis.¹⁷ The study postulates that African American children with mild and moderate autism did not receive timely evaluation.

Differences in presentation of ASD may also exist. Mandell et al⁵ found that African American children with ASD were more likely to have a lower IQ than white children. It is possible that these differences in IQ could lead to differences in service use. If only African American children with a lower IQ are being appropriately diagnosed with ASD (ie, African American children with an IQ above 70 are being missed),

they may have difficulty reporting complaints such as GI discomfort or depression leading to fewer services. In addition to differences in IQ, a study looking at behavior noted differences between white and African American children with ASD in 5 of 10 domains.¹⁸ Using the Baby and Infant Screen for Children with Autism Traits, the authors found African American children with ASD were more likely to exhibit aggressive behaviors than their white counterparts, whereas no differences were seen in stereotypic or self-injurious behavior. More aggressive behavior in minority children could explain a decrease in service use. Minority children's difficulty with aggression could become the main focus of their clinical encounters, with other issues such as depression, anxiety, or gastrointestinal issues not addressed.

Although multiple studies address presentation and diagnosis, data on other health services are limited. Liptak et al¹⁹ and Thomas et al²⁰ showed differences in autism-specific service use between minority and white children with ASD. Minority children were less likely to have a case manager, see a psychologist or developmental pediatrician, or use sensory integration services. Mandell and Novak²¹ showed

that Latino children are 6 times more likely to use nontraditional treatment compared with white children. In addition, African American parents may be less likely to view ASD symptoms as related to a health condition or less likely to seek care through a traditional medical system.^{5,22}

The current study builds upon previous work examining racial differences in children with ASD. The differences in subspecialty care noted in our findings could be explained by a number of factors. First, it is possible that minority children have different presentations of comorbid conditions from white children and therefore require different services. For example, white children with ASD may have more GI or psychiatric issues requiring greater service use.

Second, physician referral bias may play a role. If physicians believe that white children with ASD require more services or have higher likelihood of comorbid conditions than nonwhite children, they may refer white children for specialty care at a higher rate. Whether these higher rates reflect more appropriate care for white children or overuse of specialty services cannot be determined from our data.

Self-referral may also play a role in service use. Ming et al²³ found that parents initiated the majority of ASD referrals to their neurology practice. Patients with ASD may therefore access subspecialty care without referral from other physicians. It is important to note that although ASD is known to be associated with increased rates of co-occurring disorders, no specific standards of care exist for the evaluation and care of these comorbidities.^{22–26} Despite the lack of guidelines, many children with ASD receive care from multiple providers including neurologists, psychiatrists, gastroenterologists, and speech pathologists. Multiple studies have revealed that when a testing or treatment modality is

new, white patients have better access than minority patients.^{27–29} It is possible that in our population white patients with ASD receive care beyond the basic standard care, whereas nonwhite children receive only the minimal care necessary.³⁰

Finally, nonwhite and white children may present with similar complaints with similar rates of referral, but nonwhite children may not follow-up with referrals at the same rate as white children. Zuckerman et al³¹ showed that divergent beliefs between parents and providers regarding the importance of subspecialty referrals can lead to poor subspecialty follow-up by patients. Parents of nonwhite children with ASD may be less likely to complete a referral due to certain beliefs concerning the seriousness of the referral. African American parents also report more negative experiences with specialty care than white parents.³² These

factors may influence referral completion in our patient population.

There are several important limitations of this study. First, our data represent a limited population from 1 major academic health center in Boston. Though the population is diverse, it may not generalize to other communities. Additionally, we did not correct for geographic location in our logistic regression, which could confound our findings. In their analysis of the National Survey of Children's Health, Flores and Tomany-Korman¹⁴ found that nonwhite families were more likely to cite "transportation barrier" as a reason for unmet medical care needs. Census tract data from Massachusetts indicate large differences in geographic location by race.³³ If minority children live further from subspecialty providers, they may be less likely to see a subspecialist based on distance required to travel. Alternatively, they may receive subspecialty care at other hospitals that are

closer to their place of residence that we are not able to capture in our database. Finally, our data set is extracted from medical records and therefore relies on accurate coding of ASD and other conditions and procedures by clinicians.

Several possible implications of these findings exist. If nonwhite children use needed subspecialty care less frequently than white children, greater outreach to clinicians and minority communities may be necessary to inform them of needed subspecialty care. Alternatively, if white patients are receiving unnecessary referrals and procedures, then there is a need for better education regarding what care is appropriate. Linking children with needed and appropriate services has particular importance in ASDs, given the difficulties such children face with doctors' visits and procedures. Developing clearer practice guidelines based on evidence of the benefit of specific evaluations and procedures may help.

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ANOTHER COMPLICATION OF BACTERIAL INFECTIONS: CITRUS FRUIT SUPPLY:

*I routinely see children with infections due to multiresistant bacteria. While designing an effective therapeutic plan can be challenging, we can usually devise a regimen that works. Unfortunately, citrus growers in Florida are not so fortunate. As reported in The New York Times (U.S.: May 9, 2013), an infection caused by the bacterium *Candidatus Liberibacter asiaticus* is threatening to wipe out the Florida orange groves. The infection is spread by a tiny insect, the Asian citrus psyllid, that flies from tree to tree depositing the bacteria along the way. The bacterium does not cause human disease, but kills the citrus trees; the leaves turn yellow while the fruit turn bitter and drop from the tree early. The disease, called citrus greening, has spread relentlessly north from southern Florida and has been reported in all citrus-growing counties in Florida. While all citrus fruit trees can be infected, orange trees, the most common citrus tree in Florida, have been particularly hard hit. The estimated cost of the disease to the Florida economy over the past six years is approximately \$4.5 billion and 8,000 jobs. While scientists continue to study the problem, many orange growers (particularly those running smaller orchards) are abandoning groves and leaving the profession. Researchers are studying ways to interfere with the psyllid's reproductive cycle or develop resistant citrus trees. In the short term, growers have resorted to growing young orange trees indoors and have increased use of insecticides to curtail the insect population. Clearly, bacterial infections are a problem not only for humans but for plants as well.*

Noted by WVR, MD

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