

Inpatient Treatment of Acute Otitis Media at a Pediatric Hospital: A Missed Teaching Opportunity for Antimicrobial Stewardship

Christine E. MacBrayne, PharmD, MSCS,^a Manon C. Williams, MA,^b Nicole M. Poole, MD,^b Kelly Pearce, BA,^c Jillian M. Cotter, MD, MSCS,^d Sarah K. Parker, MD^{b,c}

ABSTRACT

BACKGROUND: Acute otitis media (AOM) is a common pediatric condition known to contribute to excessive antibiotic use in the outpatient setting. Treatment of AOM in the inpatient setting has not been described. The objective was to describe the clinical features and inpatient management of AOM to harness this entity to teach learners about judicious antibiotic prescribing in all settings.

METHODS: This is a single-center retrospective cohort study of inpatients treated for AOM from January 2015 to December 2018. Patients were included if they had an antibiotic ordered and either a provider-selected order indication of otitis media or an *International Classification of Diseases, 10th Revision* billing code of AOM. A chart review was performed to identify primary diagnoses, examination features, and treatment, including excess days of therapy.

RESULTS: We included 840 hospitalized patients treated for AOM in this study. At least 71% of patients had a concurrent viral respiratory illness. Examinations were frequently discordant (34%), and 47% lacked documentation of a physical examination finding of a bulging tympanic membrane, contributing to 3417 potential excess days of therapy. Of the total patients treated for AOM, 40% were given excess duration of therapy. The vast majority (97%) of patients who qualified for a wait-and-watch approach were treated.

CONCLUSIONS: AOM is not being rigorously diagnosed or treated in a guideline-adherent manner in the inpatient setting. This is a lost opportunity for teaching antibiotic stewardship. Interventions, such as promoting the wait-and-watch approach and deferring treatment decisions to inpatient providers, could help promote the judicious use of antibiotics.

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Address correspondence to Christine MacBrayne, PharmD, MSCS, Department of Pharmacy, Children's Hospital Colorado, 13123 E 16th Ave, B375, Aurora, CO 80045. christine.macbrayne@childrenscolorado.org

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^aDepartment of Pharmacy, Children's Hospital Colorado, Aurora, Colorado; and ^bDepartments of Pediatric Infectious Diseases, ^cEpidemiology, and ^dPediatric Hospital Medicine, School of Medicine, University of Colorado and Children's Hospital Colorado, Aurora, Colorado

Inappropriate treatment of acute otitis media (AOM) is a well-described phenomenon in the outpatient setting^{1–5} and leads to unnecessary adverse drug events and increased bacterial resistance.^{6,7} To our knowledge, the treatment of AOM in the inpatient setting, apart from its complications, has not been described.⁸

Children's Hospital Colorado (CHCO) requires a provider-selected order indication (PSOI) with each antibiotic order, which has revealed that inpatient treatment of AOM is surprisingly frequent.⁹ In current guidelines, the American Academy of Pediatrics stresses accurate otoscopic examination with a bulging or perforated tympanic membrane (TM) as required criteria. Antibiotic treatment versus a wait-and-watch approach is based on patient age, bilaterality, and the presence of otorrhea, pain, and fever.¹⁰ Duration of therapy ranges from 5 to 10 days on the basis of age, although the need for durations >5 days is debated.^{10–14} Our objective was to describe the inpatient care of AOM, including documentation of minimal treatment criteria (bulging TM) and duration of antibiotic therapy, to highlight opportunities to use AOM as a teaching tool for accurate diagnosis and judicious prescribing, applicable to both inpatient and outpatient settings.

METHODS

Setting, Study Design, and Participants

This is a single-center retrospective cohort study performed at CHCO, a freestanding, quaternary care pediatric hospital in the West. There are 444 licensed beds, ~97 000 patient days, and 15 000 admissions yearly. CHCO has a robust antimicrobial stewardship program that employs the handshake stewardship model, which entails a daily review of anti-infective orders and daily in-person rounds to all units of the hospital.^{15–18} Mandatory PSOIs, tailored to each antibiotic, have been in place since 2015 and have been validated as accurate and effective.^{9,19}

We included all patients who were hospitalized from January 2015 to December 2018 and had either a PSOI of

otitis media or a primary or secondary discharge diagnosis of AOM (*International Classification of Diseases, 10th Revision* codes H65–H66); these were identified in the CHCO infection control and epidemiology data warehouse, which includes all patient-level data found in the electronic medical record (EMR) (Epic Systems, Verona, WI). Antibiotics with a PSOI for AOM include amoxicillin, amoxicillin and clavulanic acid, cefdinir, cefpodoxime, ceftriaxone, and levofloxacin.

Descriptive Data Collection and Calculated Measures

All other clinical data were retrieved by chart review of medical notes, medication administration and prescription records, and microbiology data. These data were collected in Research Electronic Data Capture (Vanderbilt University, Nashville, TN) and assessed for exclusions. Patients with immunocompromising conditions, recent ear surgery, or treatment of a concurrent bacterial infection were excluded. Data collected for this descriptive study included sociodemographic data, documented symptoms and examination findings of the ears (the most abnormal examination findings were collected for the emergency department [ED] and inpatient units), discharge diagnoses, and treatment information (preadmission outpatient prescriptions, inpatient and discharge prescriptions, and drug prescribed, date, and duration). Documentation of a bulging TM, a cornerstone of the diagnostic criteria, was used to evaluate if antibiotic treatment was indicated. For example, if an antibiotic had a PSOI of AOM, the chart was reviewed to confirm AOM documented as the reason for treatment and confirm that other entities (eg, pneumonia) were not also being treated by said antibiotics. Excess treatment duration was calculated in days according to national guidelines, without judging if a child met criteria for treatment: 10 days for those <2 years and 7 days for those 2 to 5 and >6 years (expected days of therapy [DOTs] was never 0).¹⁰ This was calculated by summing all days prescribed, inpatient plus outpatient. We evaluated the percentage of patients with excess duration and the excess days per patient. If obtained, respiratory polymerase chain reaction

(the BioFire FilmArray respiratory pathogen panel [RPP], which detects 17 viruses and 3 bacteria) results were included.

We identified the number of patients who qualified for a wait-and-watch approach and calculated the percentage in whom this approach was used. As per national guidelines,¹⁰ patients were considered to qualify for a wait-and-watch approach if they were ≥24 months of age and had nonsevere (no otalgia, otorrhea, or fever ≥39°C) unilateral or bilateral AOM or if they were <24 months of age and had nonsevere unilateral AOM. For AOM severity, persistent otalgia or fever was conservatively defined as any record of ear pain or ear tugging and recorded fever >39°C. Examinations in the ED versus inpatient setting were compared for discordance, defined as a normal examination finding in 1 setting and an abnormal finding in the other.

Statistical Analysis

Descriptive statistics were used for this analysis.

This study was approved by CHCO's Organizational Research Risk and Quality Improvement Review Panel (2002-12).

RESULTS

Over 3 years, 1443 AOM episodes were identified. After exclusions, 840 AOM episodes (in 818 patients) were included in the study; 830 (99%) were captured by PSOI, and 10 (1%) were captured by *International Classification of Diseases, 10th Revision* code only. Most patients were male (58%); the mean age was 1.9 years, and 72% of the total population was ≤2 years of age. Demographically, 66% of the population was white ($n = 553$), 6% black or African American ($n = 53$), 5% >1 race ($n = 44$), and 22% other or not reported ($n = 189$); for ethnicity, 32% ($n = 269$) of the patients were Hispanic and/or Latino. The most common primary billing diagnoses were bronchiolitis (458; 56%), viral pneumonia (130; 15%), respiratory illness or hypoxemia (44; 5%), and asthma (32, 4%). A total of 361 patients had an RPP performed, of whom 279 (77%) had at least 1 virus (Table 1), and 78% of the episodes occurred during respiratory season (December to April).

TABLE 1 RPP

	n (%)
Otitis media episodes	840
Episodes in which an RPP was performed	361
RSV	145 (40)
Rhinovirus or enterovirus	106 (29)
Adenovirus	58 (16)
Human metapneumovirus	36 (10)
Coronaviruses HKU1, NL63, OC43, 229E	25 (7)
Parainfluenza 1–4	23 (7)
Influenza A and H and H3 subtypes	16 (4)
Influenza B, both clades detected	10 (3)
Negative results or no species detected	82 (23)
No RPP performed	479

The CHCO RPP also contains *Mycoplasma pneumoniae*, *Chlamydomphila pneumoniae*, and *Bordetella pertussis*, but we removed these from the table because of our exclusion of bacterial infection. Patients could be positive for >1 organism, which is reflected in the table because the number of positive organisms adds up to 419 pathogens over 279 tests with an additionally 82 tests with no species detected.

DISCUSSION

Inpatient management of AOM is a missed opportunity for teaching the importance of diagnostic criteria, use of national guidelines, and antibiotic stewardship. At a quaternary care pediatric hospital, we found that many patients treated for AOM in the inpatient setting likely did not qualify for treatment or received excess durations of antibiotics. Seventy-one percent of patients diagnosed with AOM had a concurrent diagnosis of viral bronchiolitis or pneumonitis. Although secondary bacterial infection is possible and RPP results do not always indicate an active viral infection, it is likely that many of these patients who were prescribed antibiotics had viral AOM. Furthermore, 47% of patients lacked documentation of a bulging TM and 16% recorded erythema as the only documented finding, neither of which meet criteria for treatment. Nearly 40% of children diagnosed with AOM were treated longer than necessary, amounting to at least 825 excess DOTs. The wait-and-watch approach was infrequently employed, despite the fact that the inpatient setting provides optimal opportunities for frequent reevaluations. Similar to trends noted in other studies,²⁰ 34% of examinations were discordant between the ED and inpatient setting, underlining further diagnostic challenges.

These findings highlight key opportunities for antibiotic stewardship. First, providers should ensure that patients meet diagnostic criteria according to guidelines before initiating treatment.¹⁰ Second, attention to duration when prescribing, particularly in discharge prescriptions, is another important tenet of stewardship.^{21–23} Third, an institution could consider leaving the decision to treat to the inpatient team, which may decide that wait-and-watch is appropriate, particularly in a child with a known viral illness (by diagnosis and/or virologically confirmed).^{24–27} These will all be targeted at CHCO for process improvement.

There are several limitations of this study. First, we relied on EMR documentation, which may be unreliable, particularly given features such as templated notes and copy-forward that may be used by providers. Because of this, we were conservative in

An ear examination was documented in the EMR in 819 (98%) AOM episodes. Ear examinations were recorded in both ED and inpatient settings in 607 (74%) AOM episodes, of which 209 (34%) were discordant. There was no documentation of a bulging TM in 47% of episodes. Perforation was described in 0.5% of ED and 2.4% of inpatient examinations. An examination consisting of erythema only was present in 14% of ED and 17% of inpatient examinations (Table 2).

More than half (57%) of the antibiotics were initiated before the patient's arrival in the inpatient unit. Amoxicillin was the most common (81%) antibiotic prescribed. The mean treatment duration was 9 days but

varied slightly by age: 9.1 ± 3.1 for those <2 years old, 8.7 ± 3.0 for those 2 to 5 years old, and 8.3 ± 3.5 for those ≥ 6 years old. Of the 91 AOM episodes that met criteria for the wait-and-watch approach, it was only employed in 3 patients (3%), all of whom were ≥ 24 months of age. Two patients who met treatment criteria received a wait-and-watch approach. There were 7466 total DOTs for all AOM episodes. If only duration of therapy was considered, this contributed at least 825 (11%) excess DOTs. If treatment of patients without documentation of a bulging TM was included as excess (47% of episodes), this increased the potential excess to 3417 DOTs (46%). (Table 3).

TABLE 2 AOM Signs and Symptoms

	n (%)	
	ED Examinations (n = 683; 83%)	Inpatient Examinations (n = 744; 91%)
Bulging tympanic membrane	240 (35)	318 (43)
Otorrhea, effusion, or exudate	193 (28)	279 (38)
Ear pain	42 (6)	83 (11)
Erythema	352 (52)	476 (64)
Eye discharge	14 (2)	28 (4)
Bilateral	238 (35)	307 (41)
Unilateral	208 (31)	319 (43)
Perforated TM	3 (0.5)	18 (2.4)
No sign or symptom (normal examination)	225 (33)	106 (14)

All patients included in the study: N = 840; patients with a documented ear examination: n = 819 (98%).

TABLE 3 Treatment of AOM

	Results
Antibiotic choice and duration	
Antibiotics used, <i>n</i> (%)	
Amoxicillin	679 (81)
Amoxicillin and clavulanate	144 (17)
Ceftriaxone	97 (12)
Cefdinir	66 (8)
Other oral cephalosporins	12 (1)
Ampicillin	8 (<1)
Ampicillin and sulbactam	7 (<1)
Azithromycin	5 (<1)
Ciprofloxacin	2 (<1)
Clindamycin	1 (<1)
Total duration of treatment, preadmission, inpatient, and discharge prescription in d, mean ± SD	
Overall	8.9 + 3.1
<2 y old (<i>n</i> = 602)	9.1 + 3.1
2–5 y old (<i>n</i> = 205)	8.7 + 3.0
>6 y old (<i>n</i> = 33)	8.3 + 3.5
Duration of discharge prescription from inpatient setting in d, mean ± SD	
Overall	6.7 ± 2.2
<2 y old (<i>n</i> = 602)	6.6 + 2.2
2–5 y old (<i>n</i> = 205)	6.7 + 2.1
>6 y old (<i>n</i> = 33)	6.7 + 2.6
Treatment appropriateness	
Patients who qualified for wait-and-watch, <i>n</i> (%)	
Overall	91 (11)
<2 y old (<i>n</i> = 602)	7 (1)
2–5 y old (<i>n</i> = 205)	70 (34)
>6 y old (<i>n</i> = 33)	14 (42)
No. (%) patients receiving excess duration; attributable excess DOTs ^a	
Overall	320 (38); 825
<2 y old (<i>n</i> = 602)	146 (24); 286
2–5 y old (<i>n</i> = 205)	151 (74); 465
>6 y old (<i>n</i> = 33)	23 (70); 74
No. (%) patients without documented bulging of the TM; attributable excess DOTs ^b	
Overall	394 (47); 3417
<2 y old (<i>n</i> = 602)	283 (37); 2500
2–5 y old (<i>n</i> = 205)	87 (10); 712
>6 y old (<i>n</i> = 33)	24 (3); 205

Episodes of AOM: *N* = 840.

^a Based on 10 (age <2 y) or 7 DOTs (age ≥2 y).

^b Based on considering those without bulging (47%) as not qualifying for treatment plus excess DOTs in those with bulging.

overestimated. Second, mandatory PSOI for antibiotic use is a unique EMR feature custom built by our institution^{9,19} and limits the generalizability. However, billing codes missed most patients, which emphasizes the utility of PSOs.

Our study reveals that providers do not abide by guideline-driven diagnosis and prescribing for AOM in the inpatient setting, and thus we are not harnessing a common pediatric infection to teach community responsibility for antibiotic stewardship. Antibiotic stewardship should be taught as a career-long habit for all antibiotics, not just pertinent to resistant-spectrum antibiotics in inpatient settings. For many trainees, outpatient experiences are limited, so using inpatient examples that translate to outpatient stewardship skills is important.

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our collection and analysis of qualifying clinical criteria, for example, any documented bulging of the TM and any documentation of fever or otalgia were considered as fulfilling diagnostic criteria

favoring treatment, so excess DOTs may be underestimated. On the other hand, if abnormal examination findings are documented as normal (because of templated noting), excess DOTs may be

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