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PEDIATRICS PERSPECTIVES

Structural Sequelae of the COVID Pandemic: The Youth Mental Health Crisis

Aditya Narayan, BS,[a] Stephanie D. Chao, MD[b]

A year ago, 17-year-old "Alex" was brought into the emergency department after a self-inflicted gunshot wound. Neither his primary care doctor nor his psychologist were aware of his first attempt 6 months previously. Unfortunately, this attempt was successful. It occurred in front of his home, and in front of his mother who was just seconds too late to stop him. In the aftermath, we wondered why the medical system that he had access to could not intervene in time.

Children and adolescents are populations that are particularly at risk for the consequences of mental illness and exist at the intersection of vulnerability and systemic disparities. Coronavirus disease 2019 brought mental health tensions for many youths to a tipping point, through material deprivation, frayed social connections, and consequent increases in rates of mental illness. The Youth Risk Behavior Survey by the Centers for Disease Control and Prevention revealed that, in 2021, 22% of high school students had contemplated suicide and 18% had formulated a suicide plan.[1] Amid national recovery efforts, soaring rates of gun violence, and record-high rates of substance-related overdose, we must address the mental health-related sequelae of the pandemic for vulnerable youth.

Significantly, mental health disorders among children have influence across the life course, with adolescent-onset depression increasing the risk of psychiatric issues in adulthood.[2] Accordingly, delivery system reforms have the potential to mitigate both short- and long-term consequences of psychological burdens. Unfortunately, the ongoing mental health crisis may persist after the pandemic as youth simply return to a historically underresourced system.

STRUCTURAL CHALLENGES

Imagine a family with a 14-year-old child, attempting to navigate a patchwork quilt of mental health support systems. The child's school, lacking a robust system for early detection of behavioral health issues, overlooks initial signs of depression, despite the student's declining engagement with classes. Assuming these issues are identified, the student may first meet

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Mr Narayan and Dr Chao conceptualized and designed the piece, drafted the initial manuscript, and critically reviewed and revised the manuscript; and both authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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with a school counselor, if one is available at their institution, followed by referrals to a community therapist and a psychiatrist for medication management. Each provider offers different therapeutic approaches, leading to a disjointed care experience. For other providers, piecing together a full understanding of the patient's story is daunting. Crucial data points, such as school behavioral observations, potential interactions with child protective services, and previous medical visits, are housed in distinct siloes. This decentralization hinders clinicians from attaining a comprehensive view of the patient's clinical picture, intensifying the challenges in delivering coherent and responsive care.

Adolescent mental health care suffers from insufficient delivery of care to the settings in which youth spend their time (eg, schools), poorly disseminated modalities for screening and detection of behavioral health issues, unequal quality of care across different settings, and fragmentation of services. These issues are only compounded by the dearth of mental health professionals in the United States, with a mere 14 child and adolescent psychiatrists available per 100 000 children.[3] Further complicating the picture, we must note that, for children, numerous other structures shape health care access and outcomes, including schools, social services and child welfare, and criminal justice systems. This in turn creates differing, frequently misaligned incentive structures and enormous confusion for patients. Crafting a cohesive roadmap will be necessary to redirect these trajectories.

FUTURE OPPORTUNITIES

Policy Actions

One critical policy action is investment in a centralized, interoperable registry spanning the continuum of children's mental health care services, including nonclinical stakeholders such as social service and education systems. A potential path forward is to leverage recent strides made through the 21st Century Cures Act, which aims to remove barriers to information sharing across information technology systems through standards-grade application programming interfaces. Implementing such application programming interfaces could allow electronic health record systems to interact while ideally presenting only the most actionable notifications to providers. From there, it may be feasible to draw in data from other public systems such as social services. Studies of UK health information technologies have highlighted the potential for such data consolidation across health records held by National Health Service Foundation Trusts, local health care delivery organizations, with school-based services.[4] Integrating education-related endpoints, such as attendance or school counselor evaluations, into extant electronic health records holds the potential to expand digital triaging, improve referral pathways, and advance research. However, barriers to implementing such an approach include establishing a legal and ethical approval framework within the context of the Health Insurance Portability and Accountability Act to allow for data linkage, creating shared identifiers, and appropriately investing in technological infrastructure. The US Department of Health and Human Services, as the primary agency overseeing health care and social services with a broad view of public health domains and enforcement of Health Insurance Portability and Accountability Act standards, is uniquely equipped to ensure a centralized registry meets requisite privacy and security criteria.

Additionally, despite accelerating innovations in health care financing for general medical care, payment models have not been appropriately designed to meet the needs of youth mental health professionals. It is possible to realign financial incentives to facilitate care coordination through implementation of value-based care pathways, which reward improved outcomes and decreased costs across the entirety of a child's journey in mental health services. Ideally, this reimbursement structure would also allow for diagnosis-specific outcomes and cost alignment that incentivizes child psychiatrists to accept low-income youth who are more likely to be trauma-exposed. Promising models include Medi-Cal's Children and Youth Behavioral Initiative, which seeks to create a virtual behavioral health services platform for youth and improve the continuum of care.[5]

Care Delivery and Workforce Development

We must recognize the need for systems of care spanning the breadth of a child's life beyond the hospital, from school to community. One model for care integration is Illinois Children's Healthcare Foundation led by the Healthy Minds, Healthy Children, Healthy Chicago initiative, which used a team-based approach to care coordination in community-based settings across multiple care sectors serving patients in federally qualified health centers.[6] This model led to >14 000 children being screened for mental health concerns, demonstrating the potential of such integrated interventions. To scaffold these efforts, resources must be directed to foster cross-institutional collaboration across legal, health, education, and social service systems.

To realize this improved continuum of care, however, it is necessary to increase training pathways for youth mental health professionals. Mental health workforce shortages create additional barriers to accessing care, particularly for marginalized populations that may lack coverage options. To this end, improving rates of reimbursement for child and adolescent psychiatry, which often offers lower financial margins, is necessary to encourage pursuit of the field. Moreover, we must build capacity for parents and guardians of children with behavioral health needs. As we witnessed during the pandemic, caretakers must often negotiate across

increasingly complex systems on behalf of their children. Thus, expanding Medicaid coverage for modalities such as family therapy or dyadic treatment, alongside training for caregivers, could be particularly effective. Ultimately, although recent investments in school-based mental health by the Biden administration are laudable and necessary, without multilevel reforms as described, they may not achieve their intended impact.[7]

CONCLUSIONS

The pandemic has forced a reckoning with systems in dire need of redesign. In this liminal period, although we triage the systems and policy-level changes which were initiated during the pandemic, we must not neglect vulnerable young people. We have an opportunity and responsibility to better detect, intervene, and provide longitudinal support for others like Alex so they may build fulfilling lives and futures.

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PEDIATRICS PERSPECTIVES

Earlier Testing of Infants With Perinatal Hepatitis C Exposure: A Key Step Toward Elimination

Ezzeldin Saleh, MD,[a] Ravi Jhaveri, MD[b,c]

Hepatitis C virus (HCV) infection continues to be a major national public health problem and is targeted for domestic and global elimination. Driven by the ongoing opioid epidemic, HCV incidence has been rising in the United States over the past decade, with highest infection rates among young adults including women of childbearing age.[1] This is significant because if these young adults with HCV viremia get pregnant, their infants are perinatally exposed to the virus. In 2020, as part of a strategy to increase testing of all adults, the Centers for Disease Control and Prevention (CDC) recommended universal HCV antibody screening with every pregnancy, a critical first step to improve maternal health and enhance identification of infants at risk for HCV.[2] With a 3% to 8% risk, perinatal transmission is still the most common route of HCV infection among children, and an increasing number of infants have been infected over recent years.[3] Most infants with HCV infection are asymptomatic, so the diagnosis depends on subsequent testing of perinatally exposed infants to rule out infection. Historically, it was recommended that all infants with HCV exposure be screened for anti-HCV antibodies at ≥18 months. With this previous recommendation, numerous studies consistently demonstrated that 75% to 90% of exposed infants were never tested or linked to care.[4,5] The reasons for this poor test rate are multifactorial, but a recommendation to wait 18 months in a population who often has many complicated social factors certainly was a major factor.[4,5] Frustrated by these poor rates and the high loss to follow up, many practitioners began sending HCV RNA tests earlier than 18 months. The American Association for the Study of Liver Diseases/Infectious Diseases Society of America HCV guidance panel did finally offer early HCV RNA testing as an option for perinatally exposed infants. The undebatable failure of our current approach to adequately test all HCV perinatally exposed children calls for a new national screening strategy.

In the November 2023 issue of *Morbidity and Mortality Weekly Report*, the CDC published its "Recommendations for HCV testing among perinatally exposed infants and children."[6] Based on a comprehensive literature review, the new recommendations prioritize early testing at 2 to 6 months of age with a single HCV RNA test, with alternative for HCV RNA testing up to 17 months of age for those not tested previously

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Drs Saleh and Jhaveri drafted the initial manuscript and critically reviewed and revised the manuscript; and both authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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(Fig 1). Coming at a time when most infants are being seen for well visits and immunizations, implementation of the CDC's new guidance to test all perinatally exposed infants between 2 and 6 months of age will result in increased identification and treatment of children with perinatally acquired HCV infection. Infants with undetectable HCV RNA (the vast majority) do not require any further follow-up unless clinically warranted. Infants with detectable HCV RNA can be linked to a health care provider with expertise in pediatric hepatitis C management (if available) or evaluated with local or telehealth support for eventual treatment after aged 3 years. The rationale for a single test lies in the high sensitivity (100%; 95% confidence interval, 87.5–100) and specificity (100%; 95% confidence interval, 98.3–100) of the current real-time polymerase chain reaction assays and no subsequent discordant results between subsequent antibody testing at 18 months.[7] A recent study of the new recommendation demonstrated that the accelerated testing strategy at 2 to 6 months is cost-effective (Supplemental Information).[8–24]

This revised recommendation is a very important step but is only 1 among many required to achieve comprehensive HCV elimination efforts during pregnancy and early childhood. To successfully identify all exposed infants and prevent loss to follow up and inadequate testing, universal HCV antibody screening during pregnancy must actually be implemented, with any pregnant patient having a positive screen receiving automatic reflex HCV RNA testing. Current data suggest that most prenatal providers still have not engaged in universal HCV screening during pregnancy. Seamless collaboration between obstetricians, newborn care providers, and specialists is required to ensure that, ideally, pregnant patients are treated during pregnancy (once this is recommended, the current recommendation is individualized decision-making) or at worst in the postpartum period, that HCV exposure is documented in the infants' medical records and communicated to their primary care providers, and that parents/caregivers are counseled about perinatal HCV exposure and the plan for infant testing. Other logistical steps needed to successfully implement the new testing strategy are: health care provider education about when and how to test (eg, placing the correct laboratory order, specimen collection logistics, which laboratory to send sample); shifting to exclusive

The 2023 CDC Algorithm for HCV Testing of Perinatally Exposed Children and Pediatric HCV Continuum of Care

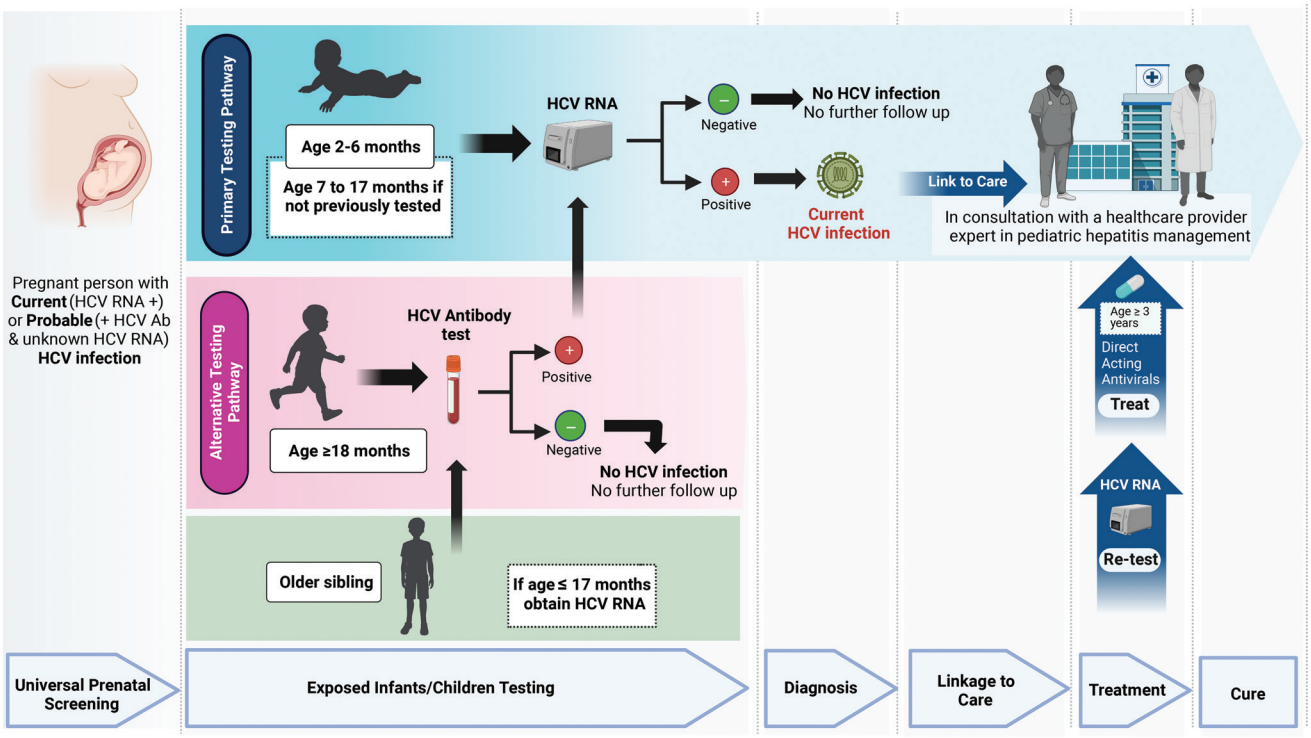

FIGURE 1

The 2023 CDC algorithm for HCV testing of perinatally exposed children and pediatric HCV continuum of care. Conceptual design of the 2023 CDC recommendations for perinatal HCV testing incorporated into a framework for pediatric HCV continuum of care, starting with universal screening of pregnant persons and emphasizing early testing of exposed infants at 2 through 6 months of age and linkage to care. This figure 1 was created with Biorender.com. CDC, Centers for Disease Control and Prevention; HCV, hepatitis C virus.

HCV RNA testing because identifying HCV viremia that requires treatment is the primary goal; evaluation of alternative sample collection (such as heel sticks) that are more easily obtained in pediatric primary care settings; coordination of care for referral to a specialist (if there is no health care provider with expertise in pediatric hepatitis C management) for follow up and retesting at approximately age 3 years when direct acting-antiviral therapy can be administered; and unobstructed access to direct acting-antiviral therapy for all patients regardless of age, which offers the promise of near 100% cure rates.

Although this process may seem daunting to design, the reality is that our health system already has an incredibly successful infrastructure in place that performs all of these steps for perinatal HIV and hepatitis B exposure and screening. These comprehensive programs have been enormously successful in achieving the near elimination of HIV and hepatitis B vertical transmission in the United States. Using the existing perinatal HIV and hepatitis B infrastructure to care for pregnant persons with HCV and their infants after delivery could provide seamless and comprehensive care with testing and treatment of all. This will take an investment of public health resources, but the more modest resources needed to expand existing systems with the promise of HCV elimination certainly seems like a good value.

The revised testing recommendation is not the end of the story. The challenge of increased HCV infections will require efforts to work "upstream" of the perinatal exposure. Can we treat most or all patients during pregnancy when we know they consistently come to appointments and are engaged in their care? Can we design and implement better prevention measures that include safer injection practices and more widespread drug treatment programs that reduce incident HCV infections?

Pediatricians reading this may ask what they need to do next. The call to action will sound very familiar to previous calls. Pediatricians need to familiarize themselves with the relevant facts of HCV vertical transmission, need to know which test to order and when, and need to coordinate with their obstetric colleagues to efficiently and confidentially share the HCV test results obtained during pregnancy to facilitate subsequent infant testing. Pediatricians are used to this role for HIV and hepatitis B, so these steps should feel very familiar.

The elimination of HCV as a public health problem will require us to identify and treat HCV in every subpopulation without exclusion ("elimination means everyone"). With these new recommendations, we move 1 step closer to a comprehensive strategy to test and treat every pregnant patient and every infant exposed so they can personally benefit from a cure of the HCV infection and be spared the risk of chronic liver disease while also being meaningfully included in our national elimination efforts.

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ABBREVIATIONS

CDC: Centers for Disease Control and Prevention
HCV: hepatitis C virus

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Bacteremia in Patients With Fever and Acute Lower Extremity Pain in a Non-Lyme Endemic Region

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Recent evidence reports that a high proportion of pediatric patients presenting to the emergency department (ED) for fever and acute lower extremity pain have positive blood cultures (BCs).[1] However, these results have not yet been validated at a different, non-Lyme endemic medical center.

METHODS

We conducted a cross-sectional study from July 1, 2018, to June 30, 2022, at a large Midwest US pediatric ED with ∼50 000 patient encounters per year. Lyme disease is rarely seen at this center.[2]

We included patients aged 1 to 18 years presenting with fever within 24 hours of presentation and acute, unilateral lower extremity pain. We excluded patients with acute traumatic injury (presenting within 24 hours of the injury), multifocal pain, immunocompromised status, indwelling central line, preexisting orthopedic comorbidity, antibiotic use within the previous 24 hours, preexisting poor bone density or joint health, and those with an identified alternative reason for limping (eg, neurologic deficits and abdominal pain) as determined by the ED physician's initial examination. The Washington University institutional review board approved this study.

We used a natural language processing-assisted manual chart review that has been previously described[1,3,4] to identify our patient cohort. Regular expressions identifying fever and lower-extremity pain (eg, "limp," "refused to bear weight," "nonweightbearing") assisted with narrowing manual review of the large cohort of patients. We trained a support-vector machine model on the manual review of charts. We reviewed additional charts identified by the support-vector machine model to achieve 95% sensitivity to identify the patients meeting inclusion criteria. We manually abstracted laboratory results, physical exam findings, and consultation notes to determine whether BC results prompted a change in patient management. We used Document Review Tools as a graphical user interface for natural language processing review and machine learning.

We used SPSS (IBM, Armonk, New York) for statistical analysis. Descriptive statistics included proportions with confidence intervals (CIs) and medians with interquartile ranges.

RESULTS

Ninety-six of 138 (70%, 95% CI 61%–77%) eligible patients had a BC drawn. Patients with a BC drawn were more likely to be admitted, 76% (95% CI 67%–84%; 73 of 96) vs 21% (95% CI 12%–36%; 9 of 42; $P < .001$).

A pathogen grew from BC in 30% (95% CI 22%–40%; 29 of 96) of patients with a BC drawn, and a contaminant grew in 3% (95% CI 1%–9%; 3 of 96). Among patients initially presenting directly to our ED (and not transferred

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Dr Rudloff conceptualized and designed the study, drafted the initial manuscript, collected data, and conducted the initial analyses; Dr El Helou collected data, and assisted with initial analyses and interpretation of the data; Mr Landschaft designed the data collection instrument and assisted with initial analyses; Drs Harper and Ahmad conceptualized and designed the study, and assisted with initial analyses and interpretation of the data; Dr Kimia conceptualized and designed the study, drafted the initial manuscript, assisted with initial analyses, and supervised the data collection and analyses; and all authors critically reviewed and revised the manuscript, approved the final manuscript as submitted, and agree to be accountable for all aspects of the work.

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from an outside hospital), the proportion with a pathogen identified by BC was 23% (95% CI 14%–34%; 16 of 71). If it is assumed that all patients without BC drawn would have had no growth of a pathogen from BC (the lowest possible bacteremia proportion for the full patient cohort), the proportion of pathogen identification is 21.0% (95% CI 15%–29%; 29 of 138).

The final diagnosis and speciation for children with BC drawn are presented in Table 1. In 15 of the 29 bacteremic patients, positive BC growth prompted change in antibiotic regimen, and in 4 patients, the positive BCs directly led to additional diagnostic evaluation, including MRI and/or arthrocentesis, leading to the final diagnosis.

Four of the 42 patients without a BC had a return visit to our ED, 2 of which were admitted for fever and dehydration. None of the 42 patients (95% CI 0%–8%) without a BC drawn had bacteremia or musculoskeletal infection subsequently identified on the basis of our manual chart review.

A larger proportion of patients with a positive BC had abnormally elevated C-reactive protein compared with patients with a negative BC or contaminant ($P < .001$), but we did not identify any difference in proportion of patients with abnormal erythrocyte sedimentation rate, absolute neutrophil count, or white blood cell count (Table 2).

DISCUSSION

In this validation study at a non-Lyme endemic center, we found a high proportion of patients presenting with fever and acute lower extremity pain had bacteremia. We believe our results support the consideration of BCs in pediatric patients presenting to the ED with fever and acute lower extremity pain.

Our study was limited to a single center, which may limit generalizability. Although the lack of Lyme disease in our patient population may account for some increase in the proportion of positive blood compared with previous reports, it is unlikely to fully account for the magnitude of this difference. Bacteremic patients were more likely to have been transferred from outside hospitals, suggesting

TABLE 1 Characteristics of Patients With a Drawn Blood Culture

Variable	BC Positive for Pathogen ($n = 29$)	BC Negative or Contaminant ($n = 67$)	P[a]
Demographics and historical elements			
Age, y, median [IQR]	7 [3.5–12]	5 [3–7]	.06
Female, *N* (%)	6 (20.7)	25 (37.3)	—
Fever duration d, median [IQR]	2 [1–4]	2 [1–3]	.99
Pain duration d, median [IQR]	3 [2–4]	2 [1–5]	.58
ESI, median [IQR]	3 [3–3]	3 [3–3]	.09
Admission, *N* (%, 95% CI)	29 (100, 88–100)	44 (69, 57–79)	<.001
Transfer from outside hospital, *N* (%, 95% CI)	13 (45, 28–63)	12 (18, 11–29)	.006
Laboratory results			
CRP mg/L, median [IQR] (*N*)	80.8 [46.1–154.3] (29)	33 [11.6–78.5] (62)	<.001
ESR mm per h, median [IQR] (*N*)	38 [24–56.5] (29)	22.5 [13.8–45.5] (62)	.04
WBC 10^9/L, median [IQR] (*N*)	9.5 [7.7–12.9] (29)	10.1 [7.1–13.3] (61)	.80
ANC 10^9/L, median [IQR] (*N*)	6.3 [4.1–8.9] (29)	6.2 [3.7–8.1] (61)	.44
ANC >10 10^9/L	6 cases	8 cases	—
Final diagnosis			
Osteomyelitis, *N* (%, 95% CI)	23 (79, 62–90)	8 (12, 6–22)	—
Septic arthritis, *N* (%, 95% CI)	4 (14, 6–31)	6 (9, 4–18)	—
Pyomyositis, *N* (%, 95% CI)	2 (7, 2–22)	—	—
Transient synovitis, *N* (%, 95% CI)	—	9 (13, 7–24)	—
Skin or soft tissue infection, *N* (%, 95% CI)	—	—	—
UTI, *N* (%, 95% CI)	—	1 (2, 0–8)	
Malignancy, *N* (%, 95% CI)	—	1 (2, 0–8)	—
Other/unspecified pain, *N* (%, 95% CI)	—	42 (63, 51–73)	—
Bacterial species			
Methicillin-sensitive *Staphylococcus aureus*, *N* (%, 95% CI)	21 (72, 54–85)	—	—
Methicillin-resistant *S. aureus*, *N* (%, 95% CI)	5 (17, 8–35)	—	—
Group A *Streptococcus*, *N* (%, 95% CI)	2 (7, 2–22)	—	—
Kingella, *N* (%, 95% CI)	1 (3, 1–17)	—	—

ANC, absolute neutrophil count; CRP, C-reactive protein; ESI, estimated severity index; ESR, erythrocyte sedimentation rate; IQR, interquartile range; *S. aureus*, *Staphylococcus aureus*; UTI, urinary tract infection; WBC, white blood cell count.

[a] Median, Mann–Whitney *U* test; 2 × 2 categorical data, χ^2 test.

TABLE 2 Proportion of Patients With Abnormal Laboratory Results

Laboratory Result	BC Positive for a Pathogen ($n = 29$)	BC Negative or Contaminant ($n = 67$)[a]	P[b]
C-reactive protein, *N* (%, 95% CI)	26 of 29 (89, 74–96)	33 of 62 (53, 41–65)	<.001
Erythrocyte sedimentation rate, *N* (%, 95% CI)	14 of 29 (48, 31–66)	19 of 62 (31, 21–43)	.10
Absolute neutrophil count, *N* (%, 95% CI)	6 of 29 (21, 10–38)	8 of 61 (13, 7–24)	.35
White blood cells, *N* (%, 95% CI)	5 of 29 (17, 8–35)	12 of 61 (20, 12–31)	.78

Abnormal cutoff values: C-reactive protein, 30 mg/L; erythrocyte sedimentation rate, 40 mm per hour; absolute neutrophil count, 10.0×10^9/L; white blood cell count, 15.0×10^9/L.
[a] Some patients in the culture negative/contaminant did not have laboratory tests ordered.
[b] 2×2 categorical data, χ^2 test.

possible selection bias. We do not have access to revisits for patients who presented to alternative health systems after discharge, limiting our ability to determine the true revisit proportion. We also urge caution extrapolating the use of C-reactive protein to determine if a BC should be obtained, because it fails to identify a low-risk group.

ABBREVIATIONS

BC: blood culture
CI: confidence interval
ED: emergency department

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Health Care Utilization After Nonfatal Firearm Injuries

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abstract

OBJECTIVES: Despite the high incidence of firearm injuries, little is known about health care utilization after nonfatal childhood firearm injuries. This study aimed to describe health care utilization and costs after a nonfatal firearm injury among Medicaid and commercially insured youth using a propensity score matched analysis.

METHODS: We conducted a propensity score matched cohort analysis using 2015 to 2018 Medicaid and Commercial Marketscan data comparing utilization in the 12-months post firearm injury for youth aged 0 to 17. We matched youth with a nonfatal firearm injury 1:1 to comparison noninjured youth on demographic and preindex variables. Outcomes included inpatient hospitalizations, emergency department (ED) visits, and outpatient visits as well as health care costs. Following propensity score matching, regression models estimated relative risks of the health care utilization outcomes, adjusting for demographic and clinical covariates.

RESULTS: We identified 2110 youth with nonfatal firearm injury. Compared with matched noninjured youth, firearm injured youth had a 5.31-fold increased risk of inpatient hospitalization (95% confidence interval [CI] 3.93–7.20), 1.49-fold increased risk of ED visit (95% CI 1.37–1.62), and 1.06-fold increased risk of outpatient visit (95% CI 1.03–1.10) 12-months postinjury. Adjusted 12-month postindex costs were $7581 (95% CI $7581–$8092) for injured youth compared with $1990 (95% CI $1862–2127) for comparison noninjured youth.

CONCLUSIONS: Youth who suffer nonfatal firearm injury have a significantly increased risk of hospitalizations, ED visits, outpatient visits, and costs in the 12 months after injury when compared with matched youth. Applied to the 11 258 US youth with nonfatal firearm injuries in 2020, estimates represent potential population health care savings of $62.9 million.

Full article can be found online via the QR code beginning January 1 or at www.pediatrics.org/cgi/doi/10.1542/peds.2022-059648

WHAT'S KNOWN ON THIS SUBJECT: Firearm injuries are a leading cause of preventable morbidity for US youth. Little is known about the magnitude of health care utilization after a nonfatal firearm injury in this population.

WHAT THIS STUDY ADDS: This study found significantly higher inpatient, Emergency Department, and outpatient visits as well as health care costs among Medicaid and Commercially insured youth in the 12 months after a firearm injury compared with noninjured youth.

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Dr Gastineau contributed to the overall study design, data interpretation, and drafted the manuscript; Drs Oddo, Simpson, and Hink contributed to the study design, interpreted findings, and revised the manuscript; Ms Maldonado and Dr Simpson drafted the statistical analysis plan, led the data acquisition and analysis, and contributed to the critical review of the manuscript; Dr Andrews conceptualized the study and oversaw all aspects of analysis, data interpretation, and manuscript critical review; all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Trends in Severe Obesity Among Children Aged 2 to 4 Years in WIC: 2010 to 2020

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abstract

OBJECTIVES: To examine the prevalence and trends in severe obesity among 16.6 million children aged 2 to 4 years enrolled in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) from 2010 to 2020.

METHODS: Severe obesity was defined as a sex-specific BMI for age ≥120% of the 95th percentile on the Centers for Disease Control and Prevention growth charts or BMI ≥35 kg/m^2. Joinpoint regression was used to identify when changes occurred in the overall trend. Logistic regression was used to compute the adjusted prevalence differences between years controlling for sex, age, and race and ethnicity.

RESULTS: The prevalence of severe obesity significantly decreased from 2.1% in 2010 to 1.8% in 2016 and then increased to 2.0% in 2020. From 2010 to 2016, the prevalence decreased significantly among all sociodemographic subgroups except for American Indian/Alaska Native (AI/AN) children. The largest decreases were among 4-year-olds, Asian/Pacific Islander and Hispanic children, and children from higher-income households. However, from 2016 to 2020, the prevalence increased significantly overall and among sociodemographic subgroups, except for AI/AN and non-Hispanic white children. The largest increases occurred in 4-year-olds and Hispanic children. Among 56 WIC agencies, the prevalence significantly declined in 17 agencies, and 1 agency (Mississippi) showed a significant increase from 2010 to 2016. In contrast, 21 agencies had significant increases, and only Alaska had a significant decrease from 2016 to 2020.

CONCLUSIONS: Although severe obesity prevalence in toddlers declined from 2010 to 2016, recent trends are upward. Early identification and access to evidence-based family healthy weight programs for at-risk children can support families and child health.

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Dr Zhao conducted the data analyses, drafted the initial manuscript, revised the manuscript, and contributed to conceptualization of the study; Drs Freedman, Blanck, and Park contributed to the conceptualization, writing, reviewing, and editing of the manuscript; and all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention.

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WHAT'S KNOWN ON THIS SUBJECT: The prevalence of severe obesity among low-income children modestly declined from 2004 to 2014. However, little is known about (1) whether this declining trend has continued and (2) the state-level prevalence and trends in severe obesity.

WHAT THIS STUDY ADDS: The declining trends in severe obesity among 16.6 million low-income children between 2010 and 2016 have been reversed. The upward trends are concerning. Early identification and referral to family healthy weight programs for at-risk children can support healthy child growth.

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Severe Obesity in Toddlers: A Canary in the Coal Mine for the Health of Future Generations

Sarah C. Armstrong, MD, Asheley C. Skinner, PhD

In this issue of *Pediatrics*, Zhao et al[1] report a small but significant increase in the prevalence of severe obesity among the 16.6 million children aged 2 to 4 years participating in the Women, Infants, and Children (WIC) program between 2016 and 2020. This represents a reversal of previous decreases in severe obesity among this same group from 2010 to 2016. Severe obesity in childhood is defined as having a BMI ≥120% of the 95th percentile, which approximates 2 SDs above the mean. It is critical to note that the development of severe obesity this early in life is nearly irreversible.

Gesserick et al modeled accelerated BMI increase in early childhood and risk of sustained obesity, finding that 90% of children who develop obesity by age 3 will still have obesity by adolescence.[2] Severe early-onset obesity is correlated with earlier and more severe risk for chronic disease; Lycett et al demonstrated that high BMI at age 2 is associated with increased metabolic syndrome risk score at age 11.[3]

Severe obesity is different than milder forms of overweight and obesity; reliable and representative national data show that severe obesity in childhood is strongly associated with high blood pressure, dyslipidemia, prediabetes, and early mortality.[4] Thus, these new data from Zhao et al showing reversal of previous progress, with an increase in severe obesity in children aged 2 to 4 years, is a cause for great concern for policymakers, clinicians, and public health professionals.

Currently, there is little understanding about what effectively treats obesity before age 6 years. The 2023 American Academy of Pediatrics Clinical Practice Guidelines (CPG) for the Evaluation and Treatment of Children and Adolescents with Obesity is based on graded evidence review of >16 000 studies evaluating treatment of children with obesity.[5] Of these, only 40 studies included any children aged <5 years (and only 13 included 2-year-olds), all involved behavioral counseling, and few demonstrated effective BMI reduction.[6] In the final recommendations, treatment options for children under aged <6 years include motivational interviewing (strong evidence) and intensive health behavior and lifestyle treatment (moderate evidence). None of the pharmacotherapy or surgical trials included in the CPG involved children <5 years; it is unclear whether these options will, or should, ever be used among preschoolers.

Prevention of early life obesity involves addressing multiple interrelated factors with different drivers. Malihi et al measured various social and behavioral factors among infants at age 9 months to determine which factors influenced excess weight gain by age 4.5 years.[7] Of multiple factors considered, food insecurity (FI) (relative risk [RR] 1.32) was most strongly associated with obesity, followed by sleep duration of <11 hours a day (RR 1.3), daily consumption of fast food or soft drink (RR 1.25), and screen time >1 hour a day (RR 1.22). All combined, these 4 factors accounted for 43% of obesity risk in this population by age 4.5 years. Thus, effective prevention of early life obesity will need to target multiple behavioral and social drivers to be successful.

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Drs Armstrong and Skinner drafted the commentary and reviewed it critically for important intellectual content; and both authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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FI and obesity have a complex relationship; although it seems paradoxical that decreased access to food would lead to increased adiposity, multiple studies have confirmed a positive relationship between FI and obesity in adults, particularly among women.[8,9] A proposed explanation is that FI leads to financial trade-offs, with basic needs (eg, housing) forcing the purchase of cheaper foods that tend to be energy-dense but with low nutritional value.[10] Indeed, adults[11] and teens[12] with FI have poorer dietary quality as compared with food-secure peers. A 2022 systematic review of FI and obesity among infants and young children found an association for those experiencing multiple episodes of FI, younger age at the time of FI, and among girls.[13] Females at all ages are at higher risk for developing obesity in the setting of FI; the reasons for this are unclear; suggested hypotheses involve biologic and metabolic responses, or social factors including stress and anxiety, in response to hunger and food scarcity.[14] Poverty plays an important role in the association between obesity and FI. Data from the Early Childhood Longitudinal Study show a mixed association between FI and obesity in younger children; however, this cohort had a low overall prevalence of FI (1.2% between kindergarten and middle school).[15] By comparison, a study including a low-income sample of nearly 30 000 infants (59% racial or ethnic minority group) with a baseline FI prevalence of 24% found that FI was associated with a 22% greater odds of child obesity as compared with matched infants living in food-secure households.[16] FI is also associated with less successful obesity treatment of children, challenging even our limited options for treatment in this age group.[17,18]

It will be important to continue the surveillance initiated by Zhao and colleagues in this early childhood and low-income group. However, these data are likely to underestimate the current prevalence of severe obesity in toddlers. The time period evaluated in this study does not capture pandemic-related changes. During the coronavirus disease 2019 (COVID-19) pandemic, BMI increased at double the previous rate, particularly for children who had obesity before the pandemic.[19] In addition, these data do not include children who qualify for WIC but are not enrolled, a group that is at greater risk of FI than the rest of the population. Over 50% percent of US children qualify for WIC, and although 82% of those who qualify are enrolled in infancy, this drops to only 57% at 1 year and only 24% by age 4.[20]

These findings suggest strategies that may be explored in future research. First, the most evidence-based nutrition program aimed at preventing FI in young children is the WIC program.[20] Although WIC participation is associated with improved child diet quality and may improve household food security, WIC has not yet demonstrated effectiveness in preventing or reversing early life obesity.[21] One explanation is that the benefits are simply not enough. Future data from the COVID-19 pandemic years may provide some insights. In the year after the onset of the COVID-19 pandemic (February 2020 and February 2021), waivers permitted the use of remote enrollment and benefit issuance, as well as certain flexibility in products. Over this period, WIC participation increased by 9.7% for children.[22] In March 2021, the American Rescue Plan included a provision that increased the WIC package from $9 per month for children to $35 per month, specifically focused on fruits and vegetables. Although this increase was temporary, the multiple extensions may allow adequate time for future data to examine differences in BMI and FI with these increased benefits.

Next, given the strong association between FI and future obesity at this early age, future obesity prevention and treatment research may include policies or interventions to treat FI in novel ways. Questions remain as to how and in what way food and nutrition can be most effectively delivered. For example, how much additional food assistance is needed to overcome FI? Should that assistance be provided with restrictions (eg, limited food choice) or no restrictions (eg, child tax credit)?

Although many questions remain, the urgency to act quickly and with a focus on social drivers of health is clear. Interventions, whether aimed at preventing or treating early life obesity, will be most effective if they follow the general principles of the 2023 American Academy of Pediatrics CPG, including whole-child care, addressing social and structural drivers of health, and providing nonstigmatizing options for families.

ABBREVIATIONS

COVID-19: coronavirus disease 2019
CPG: Clinical Practice Guidelines
FI: food insecurity
RR: relative risk
WIC: Women, Infants, and Children

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Short Oral Antibiotic Therapy for Pediatric Febrile Urinary Tract Infections: A Randomized Trial

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abstract

BACKGROUND AND OBJECTIVES: Febrile urinary tract infection (fUTI) in well-appearing children is conventionally treated with a standard 10-day course of oral antibiotic. The objective of this study is to determine the noninferiority (5% threshold) of a 5-day amoxicillin-clavulanate course compared with a 10-day regimen to treat fUTIs.

METHODS: This is a multicenter, investigator-initiated, parallel-group, randomized, controlled trial. We randomly assigned children aged 3 months to 5 years with a noncomplicated fUTI to receive amoxicillin-clavulanate 50 + 7.12 mg/kg/day orally in 3 divided doses for 5 or 10 days. The primary end point was the recurrence of a urinary tract infection within 30 days after the completion of therapy. Secondary end points were the difference in prevalence of clinical recovery, adverse drug-related events, and resistance to amoxicillin-clavulanic acid and/or to other antibiotics when a recurrent infection occurred.

RESULTS: From May 2020 through September 2022, 175 children were assessed for eligibility and 142 underwent randomization. The recurrence rate within 30 days of the end of therapy was 2.8% (2/72) in the short group and 14.3% (10/70) in the standard group. The difference between the 2 groups was −11.51% (95% confidence interval, −20.54 to −2.47). The recurrence rate of fUTI within 30 days from the end of therapy was 1.4% (1/72) in the short group and 5.7% (4/70) in the standard group (95% confidence interval, −10.4 to 1.75).

CONCLUSIONS: This study demonstrates that a 5-day course is noninferior to a 10-day course of oral amoxicillin-clavulanate.

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Drs Tessitore and Console reviewed the literature and wrote the first draft of the manuscript; Dr Ronfani designed the data collection instruments, collected data, and carried out the initial analyses; Drs Pennesi, Barbi, and Montini critically revised the manuscript for relevant intellectual content; all authors had full access to all the data in the study and had final responsibility for the decision to submit for publication; and all authors read and approved the final manuscript.

This trial has been registered at www.clinicaltrials.gov (identifier NCT04400110).

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WHAT'S KNOWN ON THIS SUBJECT: Most guidelines recommend a duration of antibiotic treatment of noncomplicated febrile urinary tract infections of 7 to 14 days, with a 10-day course being standard. No trial has evaluated the efficacy of a shorter duration of the treatment.

WHAT THIS STUDY ADDS: In this multicenter, parallel-group, randomized, controlled trial that included 142 children aged 3 months to 5 years, a 5-day treatment with oral amoxicillin-clavulanic acid for an acute febrile urinary tract infection was not inferior to a 10-day course.

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Are We Ready for Short Antibiotic Courses for Febrile Urinary Tract Infections in Young Children?

Charles R. Woods, MD, MS, James G. Atherton, PhD, MD

Shorter courses of antimicrobial therapy for bacterial infections potentially reduce[1] antimicrobial resistance (colonization and infection) at individual and population levels,[2] adverse effects of therapy,[3] costs of therapy, and[4] possibly, long-term adverse impacts on the host microbiome.[1–4] Current guidelines in the United States and Europe recommend 7 to 14 days of therapy for urinary tract infection (UTI) in children,[5,6] but comparative data on treatment courses in children are limited, despite UTI being the most common bacterial infection in children and adults.[7,8] Identifying effective shorter courses would be of great benefit, with caveats that undertreatment could have short- (eg, acute kidney injury, sepsis) and long-term consequences (eg, hypertension, renal scarring [ie, nephron loss]).[8]

In this issue of *Pediatrics*, Montini et al[9] report results from a randomized trial comparing 5- versus 10-day courses of oral amoxicillin-clavulanate for the treatment of febrile UTI in children aged 3 months to 5 years (Short-Course Oral Antibiotic Therapy of Acute Pyelonephritis in Children [STOP] trial). The authors of STOP evaluated 172 children (66% female) from 8 pediatric emergency departments in Italy from May 2020 through September 2022. The treatment groups did not differ in primary endpoints or adverse events. The recurrence rate of any symptomatic UTI within 30 days of the end of therapy was 2.8% (2/72) with 5 days versus 14% (10/70) with 10 days, with a risk difference of −11.5% (95% confidence interval [CI] −20.5% to −2.5%). The recurrence of febrile UTI in this time frame was 1.4% (1/72) versus 5.7% (4/70), with a risk difference of 4.3% (95% CI −10% to 1.8%). All patients completed 30 days of follow-up. Five of 6 recurrent UTIs were caused by microbes resistant to amoxicillin-clavulanate (2 in the 5-day group and 3 in the 10-day group).[9]

The results of STOP contrast with those of the recently published Short-Course Therapy for UTI in Children (SCOUT) trial,[10] the authors of which also compared 5 versus 10 days of therapy for UTI in children. The authors of this randomized, placebo-controlled trial evaluated 664 children aged 2 months to 10 years (62% afebrile, 96% female, 23% >6 years old) at 2 US hospitals from May 2012 through February 2023. Treatment failure by day 11 to 14 occurred in 4.2% (14/336) assigned to short-course therapy versus 0.6% (2/328) assigned to longer therapy. The risk difference was 3.6% ($P < .01$, upper bound of 95% CI, 5.5%). The groups did not differ in the secondary outcome of UTI recurrence after the 11- to 14-day visit, adverse events, or antimicrobial resistance in stool specimens at 24 to 30 days of follow-up.[10]

What are we to make of these disparate results? Variations in definitions, population, and procedures matter when trying to make such determinations. The authors of STOP defined febrile UTI as the presence of fever >38°C with a positive urine dipstick for nitrite or leukocyte esterase in a urine specimen collected by clean catch or urinary bag. The isolation of a single species in a culture of urine obtained by clean catch (≥100 000 colony-forming units [CFU]/mL) or bladder catheterization (≥10 000 CFU/mL) was required for confirmation.[9]

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Drs Woods and Atherton drafted the commentary and reviewed it critically for important intellectual content; and both authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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The STOP exclusion criteria included having complicated febrile UTI (defined as persistence of fever >48 hours after commencing treatment), the need to change the antibiotic regimen, dehydration, vomiting, adherence concerns, the presence of a urinary catheter, immunodeficiency, and neurogenic bladder. Randomization (on day 4 after enrollment after culture results were available) was stratified by the isolation of *Escherichia coli* versus non-*E. coli* microbes. The treatment duration was unblinded. Of the total number of study participants, 13 had grade III or higher vesicoureteral reflux (VUR).[9]

The authors of SCOUT defined UTI as (1) the presence of 1 or more of fever (at least 38°C), suprapubic, abdominal, or flank pain, urinary urgency, frequency, or hesitancy, dysuria, and poor feeding or vomiting, (2) pyuria (≥10 white blood cells/mL or 5 white blood cells/high power field) or positive leukocyte esterase of dipstick urinalysis, and (3) urine culture with the growth of a single uropathogen (≥50 000 CFU/mL, suprapubic or catheterized specimen, or ≥100 000 CFU/mL, clean voided specimen).[10]

Children were given 1 of 5 oral agents in SCOUT, with 89% receiving a β-lactam (1% amoxicillin-clavulanate); 62% were afebrile. Randomization was stratified by the presence or absence of fever and the initial antimicrobial agent. The exclusion criteria included genitourinary tract anomalies (except known grade I or II VUR), catheter-related UTI, and immunodeficiency. The authors of SCOUT recruited children from primary care sites, inpatient units, and emergency departments. The primary outcome of the recurrence of UTI between day 6 and days 11 to 14 after the initiation of therapy led to longer post-treatment follow-up for the 5-day group versus the 10-day group, potentially skewing outcome results.[10]

STOP and SCOUT have similarities but differ in multiple ways that were likely cumulatively important toward generating divergent results. It is difficult to disentangle factors in either study that identify subgroups for whom shorter courses would be appropriate or longer courses necessary. It can be challenging, clinically, to distinguish between cystitis and pyelonephritis in children[8] in real-life or clinical trials. The authors of SCOUT did not address this issue well, but the criterion of febrile UTI in STOP may (or may not) have yielded predominately subjects with pyelonephritis.

Data from STOP provide some comfort that 5 days of oral therapy in young children with uncomplicated febrile UTI might be sufficient. Given the almost 4-fold greater sample size and slightly more rigorous study design of SCOUT, our thoughts generally align with Milstone and Tamma in their commentary[7] on that study:

- Currently available direct and indirect (adult) data support treating UTI in children that appears limited to cystitis with courses no longer than 5 days.
- When there is clinical concern for pyelonephritis, it seems prudent, until we have more data, to maintain a modest preference for courses on the order of 10 days.

This "modest preference" when pyelonephritis is suspected is, however, fully compatible with engagement in shared decision-making with primary caretakers. Choosing shorter courses with close follow-up may be reasonable after a discussion of risks and benefits, especially when the child:

- Is not ill enough to require hospitalization, and
- Does not have genitourinary tract anomalies or severe VUR for which UTI recurrence due to undertreatment may increase the risk of nephron loss to a degree that could have long-term consequences.

Meanwhile, collectively we should not STOP SCOUT-ing out the likely nuanced answers to questions regarding the optimal duration of antibiotics for young children with febrile UTI.

ABBREVIATIONS

CI: confidence interval
CFU: colony-forming unit
SCOUT: Short-Course Therapy for UTI in Children (clinical trial)
STOP: Short-Course Oral Antibiotic Therapy of Acute Pyelonephritis in Children (clinical trial)
UTI: urinary tract infection
VUR: vesicoureteral reflux

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Treatment Goals of Adolescents and Young Adults for Gender Dysphoria

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abstract

OBJECTIVES: With this study, we aim to describe transgender and nonbinary adolescents and young adults' stated gender treatment goals at the time of initial presentation to medical care.

METHODS: This is a retrospective chart review of transgender and nonbinary patients aged 10 to 24 seeking specific gender-affirming health care. Charts were reviewed for specifically stated goals of future hormonal or surgical care for gender and analyzed by the experienced or asserted gender (man, woman, nonbinary, eclectic) of participants.

RESULTS: In total, 176 patient encounters were reviewed. Of these, 71% were assigned female at birth. Most participants experienced a masculine gender (46.6%), identified as white (65.3%), and had private health insurance (73.3%). Most patients had a goal of initiating hormone therapy (97.4%) and eventual surgery (87.1%). Of those who had a surgical goal, most (87.5%) desired surgery of the chest or breast, and a minority (29.3%) desired eventual genital surgery. The second-largest gender group was patients who either declined to state an asserted gender or felt unable to describe their gender experience (eclectic, 23.3%), and this group's treatment goals did not mirror any other group's goals.

CONCLUSIONS: At the time of initial presentation to medical care for gender-specific needs, many adolescents are capable of asserting specific treatment goals. Most do not desire genital surgery. A large minority of patients decline to state an asserted gender or feel unable to assert a specific gender, and this population appears distinct from more traditional genders in terms of treatment goals.

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Dr Roden conceptualized the study, developed the data collection instrument, supervised data collection, designed the study, and drafted parts of the initial manuscript; Ms Billman and Dr Essayli completed statistical analyses, developed tables, and drafted parts of the initial manuscript; Dr Mullin collected data and drafted parts of the initial manuscript; Mx Francesco and Ms Tassi collected data; Professors Wozolek and Heppard and Dr Stuckey-Peyrot provided important intellectual content to the initial draft of the manuscript; and all authors critically reviewed and revised the manuscript, approved the final manuscript as submitted, and agree to be accountable for all aspects of the work.

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WHAT'S KNOWN ON THIS SUBJECT: Most transgender individuals seek specific hormonal or surgical interventions to improve the experience of gender incongruence, but most studies explicitly exclude people aged <18 years from analysis.

WHAT THIS STUDY ADDS: This study reveals that adolescents and young adults aged 10 to 24 years with gender incongruence or dysphoria articulate specific medical and surgical treatment goals when they present to medical care.

To cite: Roden RC, Billman M, Francesco A, et al. Treatment Goals of Adolescents and Young Adults for Gender Dysphoria. *Pediatrics.* 2024;153(1):e2023062202

Transition to Adulthood for Extremely Preterm Survivors

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abstract

OBJECTIVE: To compare transition into adulthood of survivors born extremely preterm (EP; <28 weeks' gestation) or extremely low birth weight (ELBW; <1000 g) in the postsurfactant era with term-born controls.

METHODS: Prospective longitudinal cohort study of all EP/ELBW survivors born in the State of Victoria, Australia between January 1, 1991 and December 31, 1992 and matched term-born controls. Outcomes include educational attainment, employment, financial status, romantic partnering, living arrangements, parenthood, physical health and mental health, risk-taking behaviors, life satisfaction, and interpersonal relationships at 25 years.

RESULTS: Data were available from 165 EP/ELBW and 127 control participants. Overall, there was little evidence for differences between the EP/ELBW and control groups on most comparisons after adjustment for social risk and multiple births. However, compared with controls, the EP/ELBW group was more likely to have their main source of income from government (adjusted odds ratio [aOR] 2.49, 95% confidence interval [CI] 1.21–5.13; $P = .01$) and to have never moved out of the parental home (aOR 2.13, 95% CI 1.27–3.58; $P = .01$), and fewer had ever engaged in smoking (aOR 0.52, 95% CI 0.28–0.98; $P = .04$), binge drinking (aOR 0.41, 95% CI 0.18–0.93; $P = .03$), or street drugs (aOR 0.56, 95% CI 0.32–0.98; $P = .04$).

CONCLUSIONS: Aside from clinically important differences in main income source, leaving the parental home, and reduced risk-taking behavior, survivors born EP/ELBW in the era since surfactant was introduced are transitioning into adulthood similarly to term-born controls in some areas assessed but not all.

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Dr Pigdon conducted the initial analyses and drafted the initial manuscript; Dr Mainzer supported data analysis; Dr Burnett contributed to the conceptualization and design of the study and coordinated data collection; Professors Roberts, Patton, Cheung, Wark, and Garland contributed to the conceptualization and design of the study; Dr Albesher contributed to data collection and initial data analysis; Professors Doyle, Cheong, and Anderson conceptualized and designed the study; and all authors critically reviewed and revised the manuscript, approved the final manuscript as submitted, and agree to be accountable for all aspects of the work.

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WHAT'SKNOWN ON THIS SUBJECT: There are conflicting reports on the transition into adulthood for survivors born EP/ELBW before the 1990s, but no such reports have been conducted since the introduction of exogenous surfactant. With this study, we aim to fill this gap in knowledge.

WHAT THIS STUDY ADDS: In this study, we found that EP/ELBW survivors are mostly transitioning satisfactorily into early adulthood, which is a positive message for individuals who were born EP/ELBW in the early 1990s and their families.

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Physical and Pharmacologic Restraint in Hospitalized Children With Autism Spectrum Disorder

Mary Elizabeth Calabrese, DO, MPH, Georgios Sideridis, PhD, Carol Weitzman, MD

abstract

OBJECTIVES: Children with autism spectrum disorder (ASD) have high rates of cooccurring conditions and are hospitalized longer and more frequently than children without ASD. Little is known about use of involuntary physical or pharmacologic restraint in hospitalized children with ASD. This study compares use of restraint because of violent or self-injurious behavior during inpatient pediatric hospitalization in children with ASD compared with typical peers.

METHODS: This retrospective cohort study examines electronic health records of all children aged 5 to 21 years admitted to a pediatric medical unit at a large urban hospital between October 2016 and October 2021. Billing diagnoses from inpatient encounters identified ASD and cooccurring diagnoses. Clinical orders identified physical and pharmacologic restraint. Propensity score matching ensured equivalency between ASD and matched non-ASD groups on demographic factors. Logistic regression determined the odds of restraint in children with ASD compared with children without ASD, controlling for hospitalization factors and cooccurring diagnoses.

RESULTS: Of 21 275 hospitalized children, 367 (1.7%) experienced restraint and 1187 (5.6%) had ASD. After adjusting for reason for admission, length of stay, and cooccurring mental health, developmental, and behavioral disorders, children with ASD were significantly more likely to be restrained than children without ASD (odds ratio 2.3, 95% confidence interval 1.6–3.4; $P < .001$).

CONCLUSIONS: Hospitalized children with ASD have significantly higher odds of restraint for violent or self-injurious behavior compared with children without ASD after accounting for reason for admission, length of hospitalization and cooccurring diagnoses. Work is needed to modify the hospital environment for children with ASD to reduce behavioral dysregulation and restraint.

WHAT'S KNOWN ON THIS SUBJECT: Children with autism spectrum disorder (ASD) often have cooccurring medical and behavioral health conditions, are hospitalized more frequently than typical peers, have reduced health care access, and more foregone care. They experience restraint more frequently than peers in emergency department and inpatient psychiatric settings.

WHAT THIS STUDY ADDS: This is 1 of the first studies to demonstrate that rates of physical and pharmacologic restraints are significantly higher for children with ASD who are hospitalized on inpatient pediatric units compared with hospitalized children without ASD.

To cite: Calabrese ME, Sideridis G, Weitzman C. Physical and Pharmacologic Restraint in Hospitalized Children With Autism Spectrum Disorder. *Pediatrics.* 2024;153(1): e2023062172

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Dr Calabrese conceptualized and designed the study, and drafted the initial manuscript; Dr Sideridis conducted the statistical analyses; Dr Weitzman conceptualized and designed the study; and all authors critically reviewed and revised the manuscript, approved the final manuscript as submitted, and agree to be accountable for all aspects of the work.

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Invasive Pneumococcal Disease After 2 Decades of Pneumococcal Conjugate Vaccine Use

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abstract

OBJECTIVES: We sought to describe the evolving epidemiology of invasive pneumococcal disease (IPD) among children in Massachusetts, United States, over the last 2 decades during which sequential 7-valent pneumococcal conjugate vaccines (PCV7) and 13-valent PCVs (PCV13) were implemented.

METHODS: Cases of IPD in children aged <18 years were detected between 2002 and 2021 through an enhanced population-based, statewide surveillance system. *Streptococcus pneumoniae* isolates from normally sterile sites were serotyped and evaluated for antimicrobial susceptibility. IPD incidence rates and rate ratios with 95% confidence intervals (CIs) were calculated.

RESULTS: We identified 1347 IPD cases. Incidence of IPD in children aged <18 years declined 72% over 2 decades between 2002 and 2021 (incidence rate ratios 0.28, 95% CI 0.18–0.45). IPD rates continued to decline after replacement of PCV7 with PCV13 (incidence rate ratios 0.25, 95% CI 0.16–0.39, late PCV7 era [2010] versus late PCV13 era [2021]). During the coronavirus disease 2019 pandemic years, 2020 to 2021, the rate of IPD among children aged <18 years reached 1.6 per 100 000, the lowest incidence observed over the 20 years. In PCV13 era, approximately one-third of the IPD cases in children aged >5 years had at least 1 underlying condition (98, 30.3%). Serotypes 19A and 7F contributed 342 (48.9%) of all cases before implementation of PCV13 (2002–2010). Serotype 3 (31, 8.6%), and non-PCV13 serotypes 15B/C (39, 10.8%), 33F (29, 8.0%), 23B (21, 0.8%), and 35B (17, 4.7%) were responsible for 37.8% of cases in PCV13 era (2011–2021). Penicillin nonsusceptibility continued to decline (9.8% vs 5.3% in pre-/late PCV13 era, $P = .003$), however has become more common among non-PCV13 serotypes compared with vaccine serotypes (14.8% vs 1.4%, $P < .001$).

CONCLUSIONS: Robust ongoing surveillance networks are critical for identifying emerging serotypes and development of next-generation vaccine formulations.

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Drs Yildirim, Lapidot, Pelton, and Lee, and Mr Dasthagirisaheb and Ms Hinderstein conceptualized and designed the study, conducted the initial analyses, and drafted the initial manuscript; Drs Klevens, Ivanof, and Madoff, and Ms Johnson and Ms Burns designed the data collection instruments and collected data; Drs Grant, Arguedas Mohs, and Cane reviewed the data; and all authors critically reviewed and revised (Continued)

WHAT'S KNOWN ON THIS SUBJECT: After implementation of pneumococcal conjugate vaccines, overall and vaccine-type invasive pneumococcal disease rates declined among vaccine recipients and in unvaccinated children and adults via herd immunity. Pneumococcal disease persists as a major cause of morbidity and mortality in children globally.

WHAT THIS STUDY ADDS: Nonvaccine serotypes continue to emerge under vaccine-selective and antibiotic-selective pressures, limiting overall vaccine effectiveness against pneumococcal disease. Robust ongoing surveillance networks are critical to inform development of next-generation vaccine formulations and immunization strategies.

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Trampoline Park Injury Trends

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abstract

OBJECTIVES: Trampolines are an important cause of childhood injury and focus of injury prevention. Understanding and prevention of trampoline park injury is constrained by inadequate exposure data to estimate the at-risk population. This study aimed to measure trampoline park injury incidence and time trends using industry data.

METHODS: Cross-sectional study to retrospectively analyze reported injuries and exposure in 18 trampoline parks operating in Australia and the Middle East, from 2017 to 2019. Exposure was derived from ticket sales and expressed as jumper hours. Exposure-adjusted incidence was measured using marginalized 0-inflated Poisson modeling and time trends using Joinpoint regression.

RESULTS: There were 13 256 injured trampoline park users reported from 8 387 178 jumper hours; 11% sustained significant injury. Overall, trampoline park injuries occurred at a rate of 1.14 injuries per 1000 jumper hours (95% confidence intervals 1.00 to 1.28), with rates highest for high-performance (2.11/1000 jumper hours, 1.66 to 2.56) and inflatable bag or foam pit (1.91/1000 jumper hours, 1.35 to 2.50) jumping. Significant injuries occurred at a rate of 0.11 injuries per 1000 jumper hours (0.10 to 0.13), with rates highest for high-performance (0.29/1000 jumper hours, 0.23 to 0.36), and parkour (0.22/1000 jumper hours, 0.15 to 0.28) jumping. Overall, injury rates decreased by 0.72%/month (−1.05 to −0.40) over the study period.

CONCLUSIONS: Trampoline park injuries occur in important numbers with sometimes serious consequences. However, within these safety standard-compliant parks, exposure-adjusted estimates show injuries to be uncommon and injury rates to be declining. Further reductions are required, especially severe injuries, and this study can enhance injury prevention initiatives.

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WHAT'S KNOWN ON THIS SUBJECT: Trampoline use at homes or trampoline parks is an important cause of childhood injury, including severe injury, and a focus for injury prevention. Measuring trampoline park injury has been challenging because of inadequate exposure data to define the at-risk population.

WHAT THIS STUDY ADDS: Trampoline park injuries occur in important numbers with sometimes serious consequences. However, within standard-compliant parks, exposure-adjusted estimates show injuries are uncommon and rates are declining. Further reductions are required, especially severe injuries, and this study can enhance injury prevention initiatives.

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Pediatric Sepsis Diagnosis, Management, and Sub-phenotypes

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Sepsis and septic shock are major causes of morbidity, mortality, and health care costs for children worldwide, including >3 million deaths annually and, among survivors, risk for new or worsening functional impairments, including reduced quality of life, new respiratory, nutritional, or technological assistance, and recurrent severe infections. Advances in understanding sepsis pathophysiology highlight a need to update the definition and diagnostic criteria for pediatric sepsis and septic shock, whereas new data support an increasing role for automated screening algorithms and biomarker combinations to assist earlier recognition. Once sepsis or septic shock is suspected, attention to prompt initiation of broad-spectrum empiric antimicrobial therapy, fluid resuscitation, and vasoactive medications remain key components to initial management with several new and ongoing studies offering new insights into how to optimize this approach. Ultimately, a key goal is for screening to encompass as many children as possible at risk for sepsis and trigger early treatment without increasing unnecessary broad-spectrum antibiotics and preventable hospitalizations. Although the role for adjunctive treatment with corticosteroids and other metabolic therapies remains incompletely defined, ongoing studies will soon offer updated guidance for optimal use. Finally, we are increasingly moving toward an era in which precision therapeutics will bring novel strategies to improve outcomes, especially for the subset of children with sepsis-induced multiple organ dysfunction syndrome and sepsis subphenotypes for whom antibiotics, fluid, vasoactive medications, and supportive care remain insufficient.

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abstract

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Pediatric Sport-Related Concussion: Recommendations From the Amsterdam Consensus Statement 2023

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abstract

The 6th International Consensus Conference on Concussion in Sport, Amsterdam 2022, addressed sport-related concussion (SRC) in adults, adolescents, and children. We highlight the updated evidence-base and recommendations regarding SRC in children (5–12 years) and adolescents (13–18 years). Prevention strategies demonstrate lower SRC rates with mouthguard use, policy disallowing bodychecking in ice hockey, and neuromuscular training in adolescent rugby. The Sport Concussion Assessment Tools (SCAT) demonstrate robustness with the parent and child symptom scales, with the best diagnostic discrimination within the first 72 hours postinjury. Subacute evaluation (>72 hours) requires a multimodal tool incorporating symptom scales, balance measures, cognitive, oculomotor and vestibular, mental health, and sleep assessment, to which end the Sport Concussion Office Assessment Tools (SCOAT6 [13+] and Child SCOAT6 [8–12]) were developed. Rather than strict rest, early return to light physical activity and reduced screen time facilitate recovery. Cervicovestibular rehabilitation is recommended for adolescents with dizziness, neck pain, and/or headaches for greater than 10 days. Active rehabilitation and collaborative care for adolescents with persisting symptoms for more than 30 days may decrease symptoms. No tests and measures other than standardized and validated symptom rating scales are valid for diagnosing persisting symptoms after concussion. Fluid and imaging biomarkers currently have limited clinical utility in diagnosing or assessing recovery from SRC. Improved paradigms for return to school were developed. The variable nature of disability and differences in evaluating para athletes and those of diverse ethnicity, sex, and gender are discussed, as are ethical considerations and future directions in pediatric SRC research.

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Considerations on the Use of Neonatal and Pediatric Resuscitation Guidelines for Hospitalized Neonates and Infants: On Behalf of the American Heart Association Emergency Cardiovascular Care Committee and the American Academy of Pediatrics

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Between 0.25% and 3% of admissions to the NICU, PICU, and PCICU receive cardiopulmonary resuscitation (CPR). Most CPR events occur in patients <1 year old. The incidence of CPR is 10 times higher in the NICU than at birth. Therefore, optimizing the approach to CPR in hospitalized neonates and infants is important.

At birth, the resuscitation of newborns is performed according to neonatal resuscitation guidelines. In older infants and children, resuscitation is performed according to pediatric resuscitation guidelines. Neonatal and pediatric guidelines differ in several important ways. There are no published recommendations to guide the transition from neonatal to pediatric guidelines. Therefore, hospitalized neonates and infants can be resuscitated using neonatal guidelines, pediatric guidelines, or a hybrid approach.

This report summarizes the current neonatal and pediatric resuscitation guidelines, considers how to apply them to hospitalized neonates and infants, and identifies knowledge gaps and future priorities. The lack of strong scientific data makes it impossible to provide definitive recommendations on when to transition from neonatal to pediatric resuscitation guidelines. Therefore, it is up to health care teams and institutions to decide if neonatal or pediatric guidelines are the best choice in a given location or situation, considering local circumstances, health care team preferences, and resource limitations.

abstract

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INTRODUCTION

Optimizing the approach to cardiopulmonary resuscitation (CPR) in hospitalized neonates and infants is an important issue. Many neonates and infants in the ICU experience cardiopulmonary instability or cardiopulmonary arrest. Cardiopulmonary arrest requiring CPR with chest compressions occurs in 0.25% to 1% of NICU admissions, 1.4% of PICU admissions, and 3.1% of pediatric cardiac ICU (PCICU) admissions.[1–8] Most CPR events in the NICU, PICU, and PCICU occur in patients <1 year old.[1–8] The incidence of CPR with chest compressions in the NICU is 10 times higher than the 0.06% to 0.12% incidence of CPR reported at birth.[9,10]

Resuscitation practices vary based on a patient's age, physiology of arrest, and location of care. At birth, the resuscitation of newborns is performed according to neonatal resuscitation guidelines.[10] In older infants and children, resuscitation is performed according to pediatric resuscitation guidelines.[11] Hospitalized neonates and infants can be resuscitated using neonatal guidelines, pediatric guidelines, or a hybrid approach.[12–16] Neonatal and pediatric guidelines differ in several important ways. For example, neonatal guidelines focus on effective ventilation of the newborn lung.[10] Pediatric guidelines focus on treating the etiology of arrest (respiratory, shock, arrhythmias) and providing effective cardiac compressions.[11] Neonatal and pediatric guidelines also differ in the CPR sequence, chest compression-to-ventilation ratios, coordination of breaths with compressions, and medications and other therapies.[10,11]

At some point after birth, the optimal resuscitation protocols for neonates and infants change from neonatal to pediatric.[12–16] However, there are no published recommendations to guide the transition from neonatal to pediatric resuscitation protocols.[14,16] This lack of guidance is because of the lack of evidence suggesting when—and under what circumstances—it is better to use neonatal or pediatric resuscitation protocols. Thus, in clinical practice, the choice of which guidelines to use is in the hands of the health care team or the institution.[12–14] This lack of standardization inevitably leads to variability in resuscitation practice. There is concern that variability in resuscitation practice negatively impacts the quality of care and contributes to suboptimal resuscitation outcomes.[16–18]

This report summarizes the current neonatal resuscitation and pediatric advanced life support guidelines, considers how to apply the guidelines to hospitalized neonates and infants, and identifies knowledge gaps and future priorities. We begin with a review of resuscitation guideline development. We then explore the neonatal and pediatric guidelines and examine the differences between the two. Next, we describe the use of neonatal and pediatric guidelines for hospitalized neonates and infants. Finally, we examine how systems issues can impact decision-making and discuss knowledge gaps and future directions.

RESUSCITATION GUIDELINE DEVELOPMENT

Resuscitation guidelines are developed to standardize clinical practice and improve patient outcomes. The guideline development process includes an international effort to create treatment recommendations and regional efforts to translate those recommendations into guidelines. The International Liaison Committee on Resuscitation (ILCOR) continuously evaluates the published literature and reports the findings as systematic reviews, scoping reviews, and evidence updates.[19] ILCOR findings are also published as the *Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science With Treatment Recommendations*.[20] In the United States, as of 2021, the American Heart Association (AHA) is jointly developing guidelines with the American Academy of Pediatrics (AAP). Before this time, the American Heart Association developed guidelines with pediatric input from the AAP and others. The guidelines are developed based on the ILCOR consensus on science and evidence reviews conducted by the Writing Group. A class of recommendation and level of evidence is assigned to each recommendation to guide clinical practice and provide an evidence-based rationale for each recommendation.[19] The guidelines are published as the *Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care*.[10,11] As part of the resuscitation guideline development process, the AHA and AAP continually assess the evidence and generate focused updates when breaking science occurs.

Using the resuscitation guidelines, the AHA and AAP have worked together for decades to jointly create educational courses. The educational courses applicable to neonates and infants are the Neonatal Resuscitation Program (NRP) and the Pediatric Advanced Life Support (PALS) course. The NRP is based on the Neonatal Resuscitation Guidelines.[10] The PALS course is based on the Pediatric Basic and Advanced Life Support Guidelines.[11] Because of the close connection between the guidelines and the courses, the resuscitation guidelines are often called the "NRP Guidelines" and "PALS Guidelines." In this report, we use "neonatal resuscitation guidelines" and "pediatric resuscitation guidelines" to indicate recommendations included in the 2020 Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiovascular Care.[10,11]

NEONATAL RESUSCITATION GUIDELINES

The neonatal resuscitation guidelines apply primarily to the newborn transitioning from the fluid-filled environment of the womb to the air-filled environment of the birthing room.[10] This transition starts before the time of birth and ends after the perinatal transition period. However, the concepts in the neonatal guidelines may be applied to newborns during the neonatal period (birth to 28 days) and, according to the guidelines, may be used for neonatal resuscitation anytime during the initial hospital stay.[10,11]

To survive the birth process, the newborn must establish adequate lung inflation and ventilation after birth.[10] Therefore, the neonatal resuscitation guidelines focus on managing acute respiratory compromise at birth and delivering effective positive pressure ventilation (PPV). PPV is the primary method for supporting newborns who are apneic, bradycardic, or demonstrate inadequate respiratory effort.[10] Improvements in heart rate and the establishment of spontaneous breathing or crying are signs of effective PPV in the newborn.[10]

The neonatal guidelines are presented as themes, including anticipation and preparation, cord management, initial actions, assessment of heart rate, PPV, oxygen therapy, chest compressions, vascular access, medications, volume expansion, and withholding and discontinuing resuscitation.[10] Additionally, the guidelines include recommendations on human and system performance related to neonatal resuscitation. The neonatal guidelines contain a single resuscitation algorithm (Fig 1). The algorithm describes the steps to follow to evaluate and resuscitate the newborn. Some key components of the neonatal resuscitation algorithm and neonatal resuscitation guidelines include:

- Initial evaluation: at birth, the newborn should be warmed and dried to help maintain a normal temperature. Tactile stimulation is reasonable in infants with ineffective respiratory effort after birth.[10] Auscultation is the preferred method for the initial assessment of the heart rate, but electrocardiography use may be reasonable for the rapid and accurate measurement of the newborn's heart rate.[10]
- Airway: the airway should be optimally positioned and secretions cleared if needed. PPV should be provided without delay to newborn infants who are gasping or apneic after birth or persistently bradycardic (heart rate less than 100 per min) despite appropriate initial actions (including tactile stimulation).[10]
- Breathing: providing PPV at 40 to 60 breaths per minute is reasonable.[10] Ventilation should be optimized with endotracheal intubation, if possible, before starting chest compressions.[10] Reasonable initial supplemental oxygen concentrations are 21% in newborns ≥35 weeks' gestation and 21% to 30% in newborns ≤35 weeks' gestation with subsequent oxygen titration based on pulse oximetry.[10]
- Circulation: if the heart rate remains at less than 60 beats per minute, despite adequate ventilation that results in lung inflation for at least 30 seconds, initiating chest compressions is reasonable.[10] It may be reasonable to deliver 3 compressions followed by 1 inflation (3:1 ratio) when providing chest compressions in a newborn.[10]
- Drugs and other therapies: if the heart rate has not increased to 60 beats per minute or more after optimizing ventilation and chest compressions, it may be reasonable to administer intravascular epinephrine.[10] The recommended intravascular doses of epinephrine are 0.01 to 0.03 mg/kg intravenous or intraosseous and 0.05 to 0.1 mg/kg endotracheally. Volume expansion with 10 to 20 mL/kg of normal saline (0.9% sodium chloride) or blood may be reasonable in cases of suspected hypovolemia.[10]
- Postresuscitation care: therapeutic hypothermia should be offered to newborn infants at ≥36 weeks estimated gestational age with evolving moderate-to-severe hypoxic-ischemic encephalopathy (HIE).[10]

PEDIATRIC BASIC AND ADVANCED LIFE SUPPORT GUIDELINES

The pediatric life support guidelines are a resource for lay rescuers and health care practitioners to identify and treat infants and children. The guidelines include pediatric basic and advanced life support and cover prearrest, intra-arrest, and postarrest states. The guidelines apply to the community, prehospital, and hospital environments.[11]

Pediatric advanced life support guidelines apply to neonates (less than 30 days old) after hospital discharge, infants, children, and adolescents up to 18 years of age.[11] The pediatric guidelines exclude newborns and recommend that neonatal guidelines be used at birth and during the first hospitalization after birth.[11] Previous guidelines suggested that it was reasonable to resuscitate newborns with a primary cardiac etiology of arrest, regardless of location, according to pediatric guidelines.[21] The 2018 AHA scientific statement on the resuscitation of infants and children with cardiac disease suggests that professionals resuscitating infants and children with cardiac disease use pediatric guidelines.[22] However, the statement acknowledges the limited data regarding the effects of resuscitative strategies on neonates and infants with cardiac disease.[22]

The pediatric guidelines primarily focus on managing 3 pathophysiologic states: respiratory failure, shock, and arrhythmias. Primary cardiac arrest is uncommon in pediatrics, and the etiologies of cardiopulmonary arrest are distinct from those for adults.[11] Cardiopulmonary arrest in pediatrics is usually caused by progressive respiratory failure or shock, resulting in bradycardia and cardiopulmonary failure.[11] Therefore, rapid recognition and immediate initiation of both high-quality chest compressions and effective ventilations are critical to improving outcomes in pediatric cardiopulmonary arrest.[11] However, according to the pediatric guidelines, when CPR is initiated, it may be reasonable to use a sequence of compressions first, followed by airway and breathing.[11]

In addition to the content on managing respiratory failure, shock, and arrhythmias, the pediatric guidelines also contain recommendations on treating a variety of pathophysiologic states. The pediatric guidelines include several algorithms. Figure 2 shows the 2020 Pediatric Cardiac Arrest Algorithm, and Fig 3 shows the 2020

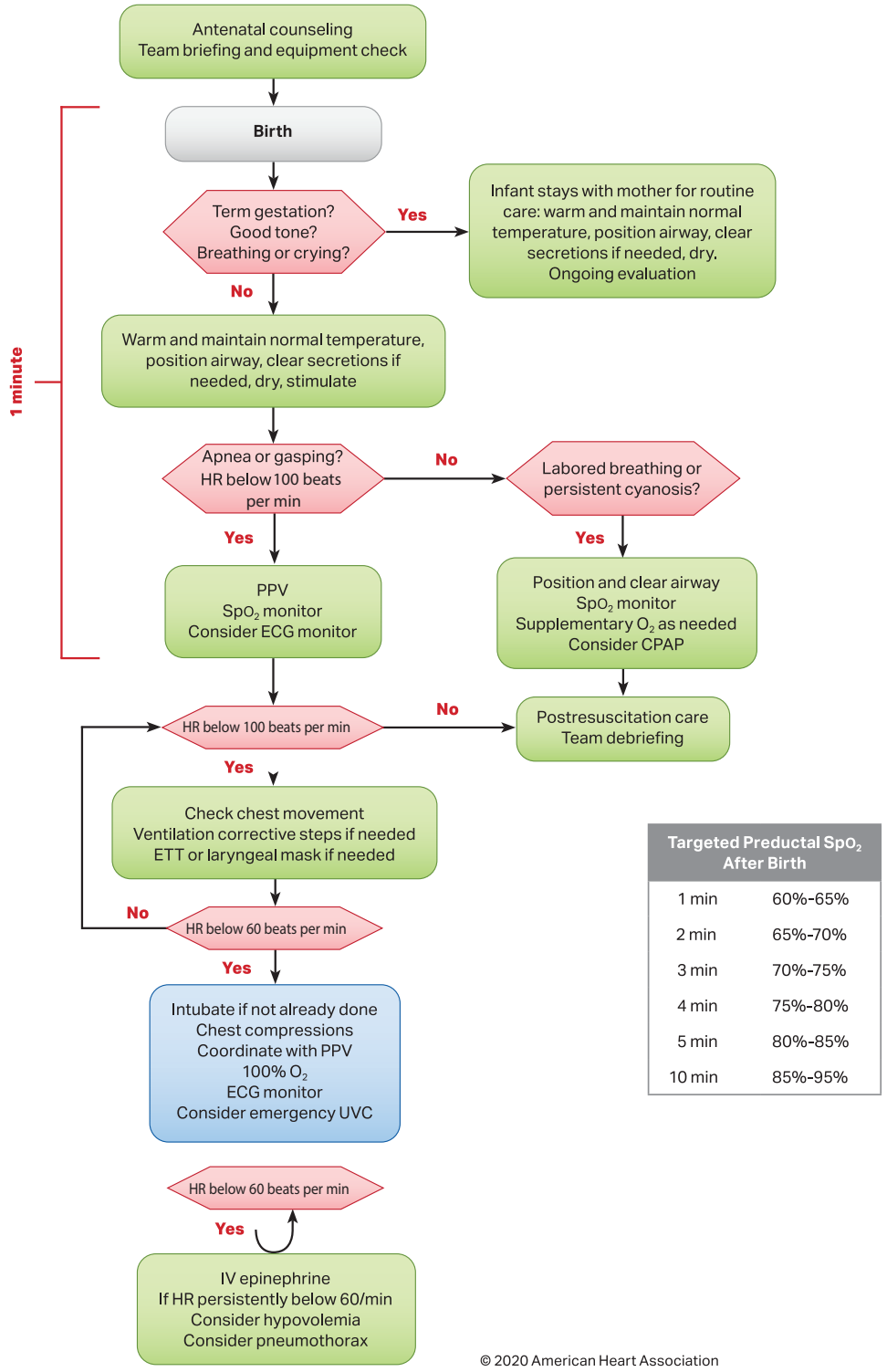

FIGURE 1
Neonatal resuscitation algorithm.

Pediatric Bradycardia With a Pulse Algorithm. Some key components of the pediatric resuscitation guidelines are noted below. Table 1 provides a high-level comparison of the neonatal and pediatric resuscitation guidelines.

- Initial evaluation: in infants and children who are unresponsive, with no breathing or only gasping, it is reasonable for health care professionals to check for a pulse for up to 10 seconds and begin compressions if no definite pulse is felt.[11]

- Circulation: when CPR is initiated, the sequence is compressions-airway-breathing.[11] Chest compressions are indicated for pulseless arrest (Fig 2) and bradycardia (heart rate <60 beats per minute) with a pulse and cardiopulmonary compromise despite effective oxygenation and ventilation (Fig 3).[11] In the absence of an advanced airway, it is reasonable for 1 rescuer to use a compression-to-ventilation ratio of 30:2 and for 2 rescuers to use a compression-to-ventilation ratio of 15:2.[11] With an advanced airway in place, it is reasonable to give 100 to 120 continuous compressions per minute with no pause for ventilation and 1 breath every 2 to 3 seconds (20–30 breaths per minute).
- Airway: bag-mask ventilation is reasonable compared with advanced airway interventions in managing children during out-of-hospital cardiopulmonary arrest.[11] Data are insufficient to support a recommendation for advanced airway use in in-hospital cardiopulmonary arrest (IHCA).[11] There may be specific circumstances or populations in which early advanced airway interventions are beneficial.[11]

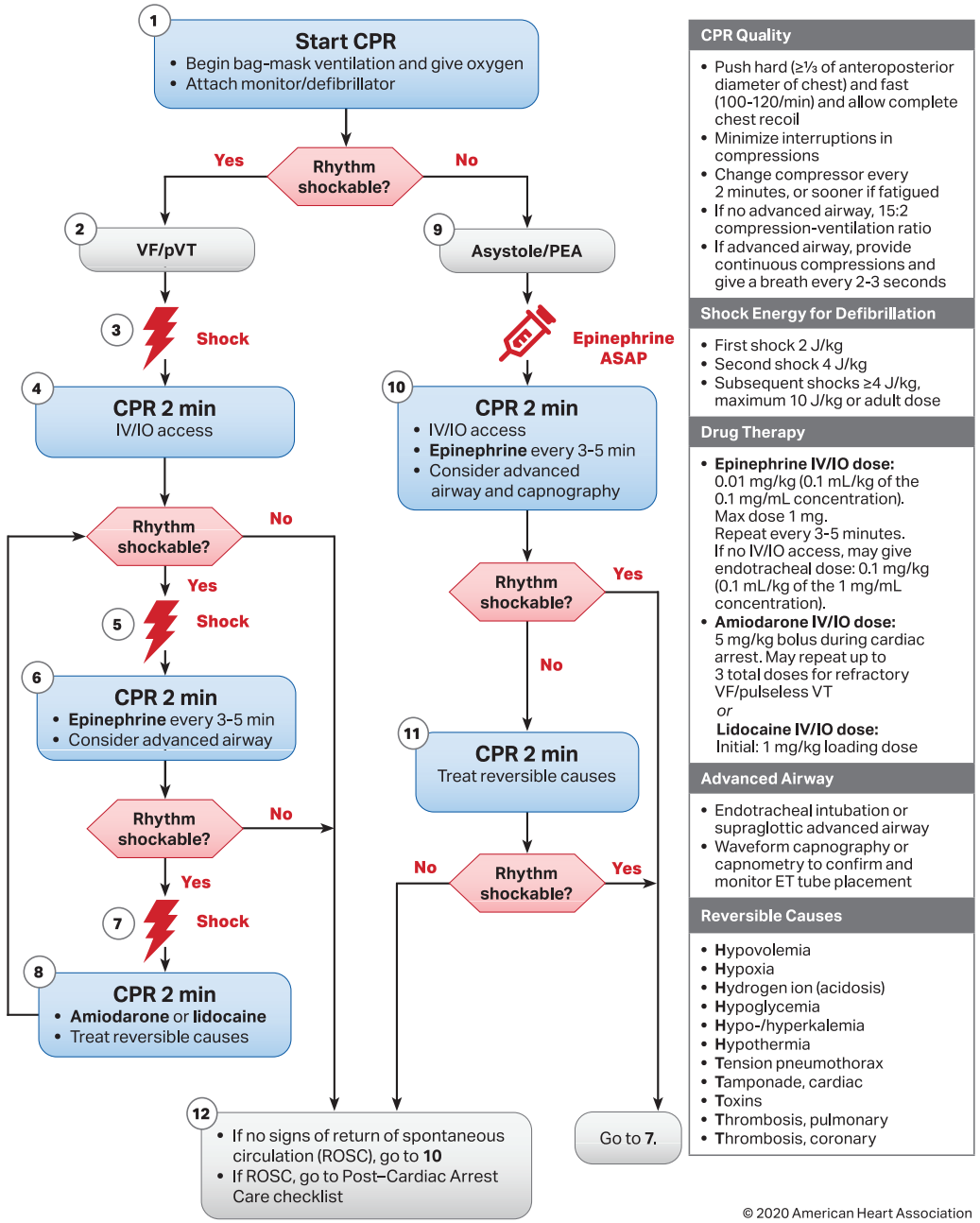

FIGURE 2
Pediatric cardiac arrest algorithm. IO, intraosseous; IV, intravenous; PEA, pulseless electrical activity.

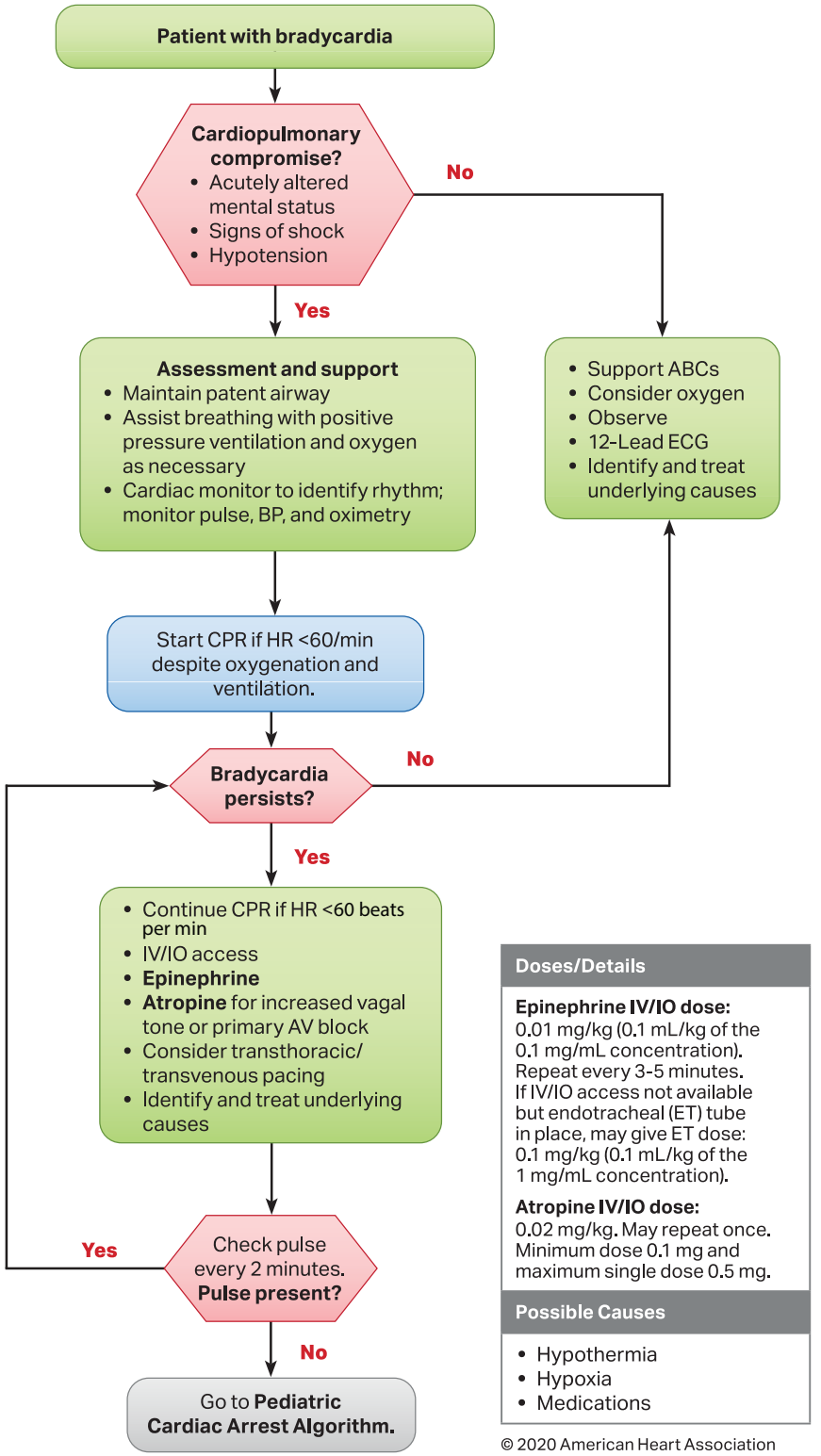

FIGURE 3
Pediatric bradycardia with a pulse algorithm. AV, atrioventricular; BP, blood pressure; IO, intraosseous; IV, intravenous.

TABLE 1 Comparison of Neonatal and Pediatric Resuscitation Guidelines

	Neonatal[10]	Pediatric[11]
Focus	Resuscitation and stabilization at birth	Life support for infants and children outside the newborn period with respiratory failure, shock, arrhythmias, and cardiopulmonary arrest
Patient population	Newborns at birth and neonates and during the first hospitalization after birth	Pediatric advanced life support guidelines apply to neonates (less than 30 d old) after hospital discharge, infants, children, and adolescents up to 18 y of age.
Chest compression initiation	Chest compressions should be initiated if the heart rate remains less than 60 beats per minute despite 30 s of adequate PPV	When CPR is initiated, the sequence is chest compressions-airway-breathing
Compression-to-ventilation ratios	• 3:1 ratio with 90 compressions and 30 breaths per minute; • no pause for ventilation regardless of rescuer number or advanced airway	Bag-mask ventilation: • 1 rescuer: 30:2; • 2 rescuers: 15:2; • pause for ventilation; advanced airway: • 100–120 continuous compressions per minute; • 1 breath every 2–3 s (20–30 breaths per min); • no pause for ventilation
Algorithms	• Neonatal resuscitation algorithm	• Pediatric Basic Life Support Algorithm for Healthcare Providers—single rescuer; • Pediatric Basic Life Support Algorithm for Healthcare Providers—2 or more rescuers; • Pediatric Cardiac Arrest Algorithm; • Pediatric Bradycardia with a Pulse Algorithm; • Pediatric Tachycardia with a Pulse Algorithm; • Opioid-Associated Emergency for Lay Responders Algorithm; • Opioid-Associated Emergency for Healthcare Providers Algorithm
Drugs and other therapies	Epinephrine; normal saline; emergency O neg blood	Drug classes: • antiarrhythmic; • vasopressors; • inotropes; • pulmonary vasodilators; • sedation or reversal agents; defibrillation, cardioversion, transcutaneous pacing, vagal maneuvers
Vascular access	UVC or IO	PIV, IO, central line
Postresuscitation temperature management	Newborns 36 wk or more estimated gestational age at birth with evolving moderate-to-severe HIE should be offered therapeutic hypothermia under clearly defined protocols	For infants and children between 24 h of age and 18 y of age who remain comatose after in-hospital cardiac arrest, it is reasonable to use either TTM of 32°C–34°C followed by TTM of 36°C–37.5°C or only TTM of 36°C–37.5°C

IO, intraosseous; PIV, peripheral IV; TTM, targeted temperature management; UVC, umbilical venous catheter.

- Breathing: when performing CPR in infants and children with an advanced airway, it may be reasonable to target a respiratory rate range of 1 breath every 2 to 3 seconds (20–30 breaths per minute), accounting for age and clinical condition.[11]
- Drugs and therapies: giving the initial dose of 0.01 mg/kg intravenous or intraosseous epinephrine within 5 min from the start of chest compressions for pediatric patients in any setting is reasonable.[11] In cases of ventricular fibrillation (VF) or pulses ventricular tachycardia (pVT), an initial dose of 2 to 4 J/kg of monophasic or biphasic energy for defibrillation is reasonable.[11]
- Postresuscitation care: for infants and children between 24 hours old and 18 years old who remain comatose after cardiopulmonary arrest, it is reasonable to use either targeted temperature management (TTM) of 32°C to 34°C followed by TTM of 36°C to 37.5°C, or only TTM of 36°C to 37.5°C.[11]

KEY DIFFERENCES BETWEEN NEONATAL AND PEDIATRIC GUIDELINES

Compression-to-Ventilation Ratios

In both neonatal and pediatric cardiopulmonary arrest, coronary perfusion is essential. The recommendations in the pediatric guidelines are aimed at directly improving coronary perfusion using higher chest compression rates and limiting pauses in compressions. The recommendations in the neonatal guidelines are aimed at indirectly improving coronary perfusion by first improving lung aeration and pulmonary perfusion using slower compression rates and pausing compressions for breaths. The different approaches to coronary perfusion explain the differences in the approach to resuscitation between the neonatal and pediatric guidelines (Table 1).

For pediatric patients in cardiopulmonary arrest, multiple, sequential chest compressions increase diastolic pressure and enhance coronary perfusion.[23] In a prospective multicenter study in the PICU, diastolic blood pressure ≥25 mm Hg during CPR was associated with a greater likelihood of survival to hospital discharge and survival with a favorable neurologic outcome.[24] The goal of increasing coronary perfusion pressure explains the prioritization of IV epinephrine in the pediatric guidelines, with the initial dose administered within 5 minutes from the start of chest compressions.[11]

The pulmonary arterial blood pressure in the fetus is high, and blood flow through the pulmonary circulation is limited. After delivery, lung expansion results in a drop

in pulmonary vascular resistance and a concomitant increase in pulmonary blood flow. Increased pulmonary blood flow, combined with alveolar expansion and oxygenation, increases the flow of oxygenated blood back to the left ventricle. This flow of oxygenated blood improves coronary artery perfusion.

In the newborn, a patent ductus arteriosus may inhibit an increase in diastolic pressure during CPR. Animal data suggest that an increase in diastolic pressure is less critical to the successful return of spontaneous circulation in newborns.[25,26] Hence, slower compression rates and interrupting compressions for ventilations may be tolerated. Data from animal models are inconclusive in terms of the optimal chest compression-to-ventilation ratio in neonatal asphyxia cardiopulmonary arrest. Ratios of 2:1, 3:1, 4:1, 5:1, 9:3, 15:2, and continuous chest compressions with asynchronous PPV are associated with similar times to return of spontaneous circulation and mortality rates.[10,27–29]

The 2020 pediatric guidelines include an updated ventilation rate of 1 breath every 2 to 3 seconds (20–30 breaths per minute) for infants and children receiving CPR with an advanced airway in place.[11] This new recommendation was based on a multicenter observational study demonstrating higher rates of return of spontaneous circulation and survival in children <1 year of age who received higher ventilation rates than previously recommended.[30] This change "narrows the gap" between neonatal and pediatric guidelines for intubated patients. However, differences persist in managing nonintubated patients, the overall number of compressions per minute (100–120 vs 90), and recommendations to synchronize compressions and pause for ventilation.

The Sequence of Resuscitation Efforts

A notable difference between the neonatal and pediatric guidelines is the sequence of steps taken during CPR. The pediatric guidelines recommend that initiating CPR with a compressions-airway-breathing (C-A-B) approach may be reasonable.[11] The C-A-B approach for pediatric resuscitation was first adopted in 2010.[31] Before that, the pediatric guidelines recommended an airway-breathing-compressions (A-B-C) approach. The reason for the change was to expedite improvements in coronary perfusion with chest compressions. Using an A-B-C approach, compressions may be delayed while preparing respiratory equipment.[31] Since chest compressions only require the hands of a willing rescuer, the C-A-B sequence allows for the immediate start of chest compressions while a second rescuer prepares for ventilation.[31] The C-A-B sequence aligns with the adult resuscitation guidelines and offers consistency in teaching rescuers that care for both children and adults.[31] It is hoped that consistency across the pediatric and adult guidelines increases the frequency of bystander pediatric CPR.[31] A recent study from Japan showed an increased rate of bystander CPR over time; however, a study from the United States showed no change.[32,33]

The neonatal guidelines state that the most important priority for newborn survival is the establishment of adequate lung inflation and ventilation after birth.[10] Thus, a primary focus of neonatal resuscitation is lung ventilation. The neonatal guidelines do not include specific language on the sequence of resuscitation efforts or make any explicit recommendations for an A-B-C approach.[10] However, according to the neonatal guidelines, ventilation should be optimized with endotracheal intubation, if possible, before starting chest compressions (Fig 1).[10]

Other Content

Since pediatric guidelines cover a wide range of life support topics, they are much broader in scope compared with neonatal guidelines. In addition to the content on respiratory failure, shock, and arrhythmias, content covered in the pediatric guidelines include the management of various arrhythmias, including VF, pVT, bradycardia, and supraventricular tachycardia; the treatment of myocarditis and cardiomyopathy; resuscitation of the patient with a single ventricle; recommendations for treating children with pulmonary hypertension; and guidelines on extracorporeal cardiopulmonary resuscitation.[11]

Postresuscitative Care

The neonatal and pediatric guidelines differ in their recommendations for postresuscitation care. The neonatal guidelines contain recommendations on the postresuscitation care of newborns who receive prolonged PPV or advanced resuscitation (eg, intubation, chest compressions ± epinephrine). The neonatal guidelines suggest that these newborns be closely monitored after stabilization in a NICU or a monitored triage area because they are at risk for further deterioration.[10] All infants ≥36 weeks estimated gestational age who receive advanced resuscitation should be examined for evidence of HIE to determine if they meet the criteria for therapeutic hypothermia.[10] Therapeutic hypothermia should be provided to newborns with moderate to severe HIE using protocols like those used in published clinical trials in facilities capable of multidisciplinary care and longitudinal follow-up.[10]

The pediatric resuscitation guidelines include recommendations on postresuscitation care outside the newborn period and contain information on postcardiopulmonary arrest syndrome.[11] The components of postcardiopulmonary arrest syndrome include brain injury, myocardial dysfunction, systemic ischemia and reperfusion response, and persistent precipitating pathophysiology.[11] The pediatric guidelines provide recommendations on TTM, blood

pressure management, oxygenation and ventilation, EEG monitoring, and seizure management.[11] Two potential strategies of postarrest temperature management are recommended for infants and children between 24 hours and 18 years of age who remain comatose after arrest.[11] Table 1 compares pediatric and neonatal postarrest temperature management guidelines.

CONSIDERATIONS ON THE USE OF NEONATAL AND PEDIATRIC GUIDELINES FOR HOSPITALIZED NEONATES AND INFANTS

What Chest Compression-to-Ventilation Ratios Should be Used?

The neonatal guidelines apply to newborns at birth and in the days after birth during the first hospitalization.[10,11] This suggests that the 3:1 compression-to-ventilation ratio recommended in the neonatal guidelines may be applied anytime during the initial hospital stay in the nursery, NICU, PICU, or PCICU. After hospital discharge and upon readmission to the hospital, the compression-to-ventilation ratios recommended by the pediatric guidelines (Table 1) may be applied.[11] The current guidelines only mention hospital discharge and do not address transfers within the hospital (eg, transfer from the NICU to the PICU or PCICU).[10,11]

There are limited data on what chest compression-to-ventilation ratios are used during the resuscitation of hospitalized neonates and infants. Survey studies in the United States suggest a location-based approach to resuscitation practice, where the choice of neonatal or pediatric compression-to-ventilation ratios is influenced more by the patient's location within the hospital (NICU, PICU, PCICU) than by first hospitalization or postdischarge status.[12,13] This location-based practice complements typical training schemes. Health care teams in the nursery and NICU typically receive NRP training. Thus, following the neonatal guidelines aligns with their training. Health care teams in the PICU and PCICU typically receive PALS training, so following the pediatric guidelines aligns with their training.

What Sequence of Resuscitation Efforts Should be Followed?

Most children receiving cardiopulmonary resuscitation in the ICU have an initial rhythm of bradycardia and poor perfusion with signs of cardiopulmonary compromise.[1,6,34] In cases of bradycardia and cardiopulmonary compromise, the initial management, according to the pediatrics guidelines, is a simultaneous assessment of the etiology and treatment by managing the airway and providing ventilation and oxygenation.[11] If bradycardia and cardiopulmonary compromise persist despite effective oxygenation and ventilation, CPR should be initiated (Fig 3).[11]

Since their inception, the neonatal guidelines have focused on lung recruitment and ventilation as the cornerstone of resuscitation at birth. This is accomplished through effective ventilation, either spontaneously or assisted via PPV. When providing facemask PPV to a newborn, mask leaks and upper airway obstruction are common and can result in ineffective ventilation.[35] Thus, neonatal resuscitation focuses on optimizing PPV and performing ventilation-corrective steps, including advanced airway placement, to promote effective ventilation before starting chest compressions.[10] In the NICU, over 80% of cardiopulmonary arrests start as an acute respiratory compromise.[1,2] Therefore, focusing on effective ventilation is critical in both the delivery room and the NICU. Simulation-based studies suggest that starting chest compressions early, before ensuring effective ventilation, may subject newborns to unneeded compressions and shift the team's focus away from establishing effective ventilation.[36]

There is no evidence that attempting ventilation-corrective steps in the newborn, including intubation if needed, before starting chest compressions is inferior to initiating chest compressions first. According to the pediatric guidelines, there are not sufficient data to support a recommendation for advanced airway use in IHCA.[11] However, there may be some situations in which early advanced airway interventions are beneficial.[11] In most CPR events in the hospital, chest compressions and ventilations are started simultaneously because most neonates and infants that undergo CPR are already intubated.[1–7] Thus, for IHCA, the differences between using the pediatric C-A-B approach or a neonatal approach, focusing on ventilation and intubation first, are likely minimal.

Can Pediatric Resuscitation Guidelines Content be Applied to the NICU?

Prior studies suggest that the content in the pediatric resuscitation guidelines applies to some patients in the NICU. For example, in a multicenter study of CPR in quaternary NICUs, Ali et al found that the etiologies of cardiopulmonary arrest associated with decreased survival to discharge included multisystem organ failure, septic shock, and pneumothorax.[1] Many of those etiologies are not explicitly addressed in neonatal guidelines. In addition, a cross-sectional survey of NICUs in Israel found that medications, diagnostic approaches, and procedures blended neonatal and pediatric guidelines.[14] Based on these reports, it seems reasonable that some pediatric resuscitation guidelines may apply in the NICU in some situations. Table 2 lists some content in the pediatric resuscitation guidelines applicable to the care of neonates and infants in the NICU.

Should Health Care Teams Receive Training in Both NRP and PALS?

A common question around resuscitation training is whether some health care teams should take both NRP

and PALS. The answer to this question depends on many factors. A key consideration is the need for the health care team to have the knowledge and skills taught in the 2 courses. Suppose health care professionals working in the emergency department, PICU, or PCICU may be called upon to participate in the resuscitation of newborns at birth. In that case, they should consider taking an NRP course. Similarly, if health care professionals working in the NICU could be called upon to participate in the resuscitation of a neonate or infant suffering from shock or an arrhythmia not covered in NRP, they should consider taking PALS.[14–16]

There are no data to suggest that attending both NRP and PALS courses improves CPR outcomes for hospitalized neonates and infants. Therefore, the decision on life support training requirements is up to the health care teams and their institutions, considering the breadth of patient age ranges that practitioners are expected to care for.

Studies suggest there is currently little cross-training of health care professionals in both NRP and PALS. A national survey of NICUs, PICUs, and PCICUs by Ali et al found that only 15% of NICU attending physicians took PALS, and only 5% of PICU attending physicians took NRP.[13] In the PCICU, 0% of attending physicians took NRP. In a study of academic neonatologists in the Midwest United States, 99% maintained NRP, but only 37% maintained PALS.[37] Data on the training of nonphysicians are limited. According to a study by Sawyer et al, only 3% of PICU nurses maintained NRP, and only 5% of NICU nurses maintained PALS.[12]

Some argue that attending formal NRP and PALS training courses is unnecessary to gain the knowledge and skills required to perform the critical components of neonatal and pediatric resuscitation competently. For example, NICU teams could learn how to treat VF or pVT with defibrillation without participating in a PALS course, and PICU teams could learn how to manage a newborn at birth without taking NRP. Informal training opportunities such as simulation-based workshops[38] and resuscitation "mini-courses"[15] have been described as ways to gain resuscitation knowledge and skills without attending a formal life support course. The impact on patient outcomes from attending such informal training is yet to be determined.

TABLE 2 Content in the Pediatric Resuscitation Guidelines Applicable to Neonates and Infants in the NICU

• Management of respiratory failure outside the newborn period
• Management of VF or pVT
• Management of bradycardia with a pulse
• Management of tachyarrhythmias, including supraventricular tachycardia
• Treatment of myocarditis and cardiomyopathy
• Resuscitation of the patient with congenital heart disease
• Treatment of pulmonary hypertension
• Extracorporeal cardiopulmonary resuscitation
• Postresuscitation care outside the newborn period

When Should Teams Transition From Neonatal to Pediatric Resuscitation Guidelines?

As the cardiopulmonary physiology of the newborn transitions to that of the neonate and infant, the evidence upon which the neonatal resuscitation guidelines are based becomes less applicable. Therefore, it makes sense to transition from neonatal to pediatric resuscitation guidelines at some point during the first days, weeks, or months after birth.[16,18] In addition to the maturational changes in cardiopulmonary physiology necessitating a change from neonatal to pediatric guidelines, some have expressed concerns about the limited scope of the neonatal resuscitation guidelines.[14,16,18] As seen in Table 1, the pediatric guidelines cover a broader array of life support and cardiopulmonary arrest topics than the neonatal guidelines. This expanded scope may be important in the NICUs when caring for neonates and infants with premorbid conditions and cardiopulmonary arrest etiologies not covered in the neonatal guidelines.[1–5]

There are no scientific data to answer the question of when to transition from neonatal to pediatric resuscitation guidelines. However, prior reports have described unit-based approaches to this issue. For example, Harer et al described their experience in a level IV NICU where pediatric guidelines were used for infants >44 weeks' postmenstrual age, those with a previous non-PDA cardiac surgery or intervention, and those with an obvious identified cardiac arrhythmia.[15] Using that strategy, 29% of NICU patient days qualified for pediatric guidelines.

Since there are no data on which to base recommendations, health care systems need to determine an approach that works best for their situation. Table 3 provides some potential approaches to transitioning from neonatal to pediatric resuscitation guidelines for hospitalized neonates and infants.

What Postresuscitative Care Guidelines Should be Followed?

The neonatal guidelines recommend therapeutic hypothermia for infants 36 weeks or older who receive prolonged PPV or advanced resuscitation at birth and have evidence of moderate to severe HIE.[10] This recommendation is based on the findings of several randomized clinical trials of neonatal therapeutic hypothermia.[39] The recommendations were not based on data from neonates treated after cardiopulmonary arrest in the nursery or NICU. According to the pediatric guidelines, it is reasonable for infants and children 24 hours or older who remain comatose after cardiopulmonary arrest to be treated with either TTM of 32°C to 34°C followed by TTM

of 36°C to 37.5°C, or only TTM of 36°C to 37.5°C.[11] There are no guidelines on the optimal postresuscitative temperature management of neonates outside the immediate newborn period who are less than 24 hours of age.

SYSTEM ISSUES TO CONSIDER

Avoiding Confusion on the Guideline to Follow

Confusion may result when either neonatal or pediatric resuscitation guidelines could be followed. For example, suppose a NICU uses neonatal guidelines for some patients and pediatric guidelines for others. In that case, team members may become confused about which resuscitation guidelines to use for a particular neonate. Evidence suggests that shared mental models correlate positively with superior performance and communication patterns.[40,41] Thus, clarity on the approaches to resuscitative practices and ensuring a shared mental model within the health care team on which resuscitation guidelines to follow is likely an important factor in improving outcomes from CPR.

Confusion around resuscitation guideline choice can be mitigated in several ways. The first and most important is having clear policies.[16] Ideally, the policies would be rooted in outcomes-based data. Unfortunately, there are no current data to guide decision-making in this area. Thus, policymakers should select the most appropriate approach for their specific situation (Table 3). Based on the policies, patients should be proactively identified, and signage should be used that specifies the recommended resuscitation guideline. Harer et al describe such an approach in a level IV NICU where pediatric resuscitation guidelines were used in select circumstances.[15]

After policies are developed and patient inclusion processes are in place, educational programs can be used for team training. Training can include case discussions and simulations. Team training events can help teams optimize

TABLE 3 Potential Approaches to Transitioning From Neonatal Resuscitation to Pediatric Advanced Life Support Guidelines for Hospitalized Neonates and Infants

Approach	Meaning	Example	Pros and Cons
Location-based	Resuscitation guidelines are based on the location of the patient in the hospital	Neonatal guidelines are used in the NICU; pediatric guidelines are used in the PICU and PCICU	Pros: easy to implement strategy; easier to conduct and maintain training; low likelihood of team confusion. Cons: older neonates in the NICU are resuscitated using neonatal guidelines designed for newborns; newborns in the PICU and PCICU are resuscitated using pediatric guidelines designed for infants; may not support neonates in the NICU with significant congenital heart disease or arrhythmias
Age-based	Resuscitation guidelines are based on the patient's age	Patients over 44 wks postmenstrual age[a] are resuscitated using pediatric guidelines; younger patients are resuscitated using neonatal guidelines	Pros: allows a transition between guidelines based on maturity of the patient. Cons: arbitrary cut point for transition; challenges conducting and maintaining training; risk of confusion among health care teams; may not support young neonates with significant congenital heart disease or arrhythmias
Patient-based	Resuscitation guidelines are based on the most likely etiology of arrest	Patients with arrhythmia and cardiac arrest are resuscitated using pediatric guidelines; Patients with respiratory arrest are resuscitated using neonatal guidelines	Pros: provides a physiologic-based approach, with an emphasis on high-quality CPR in patients with a primary cardiac etiology of arrest, and an emphasis on effective ventilation in patients with a primary respiratory etiology of arrest. Cons: it may be difficult to identify the etiology of arrest (eg, cardiac versus respiratory); challenges conducting and maintaining training; risk of confusion among health care teams
Provider-based	Resuscitation guidelines are based on the health care team's training and experience	Neonatal guidelines are used in the NICU, where providers are only required to take NRP; Pediatric guidelines are used in the PICU or PCICU, where providers are only required to take PALS; A hybrid approach may be used in units where providers take both NRP and PALS	Pros: aligns the resuscitation approach to the knowledge and skills of the health care team; Low likelihood of team confusion. Cons: older neonates in the NICU are resuscitated using neonatal guidelines designed for the newborn; young neonates in the PICU and PCICU are resuscitated using pediatric guidelines designed for infants; may not support neonates in the NICU with significant congenital heart disease or arrhythmias

[a] 44 wks postmenstrual age includes full-term gestation plus the 28 d of the "neonatal" period.

decision-making and avoid confusion in the details of resuscitation (eg, compression-to-ventilation ratios, etc). As part of a continuous quality improvement process, institutional resuscitation committees should review resuscitation performance to ensure policies are followed and determine if changes are needed. A robust system for postresuscitation debriefings is integral to CPR quality improvement and can help refine and improve resuscitative practices.[42]

Challenges in Maintaining Skills in Both Neonatal and Pediatric Resuscitation

Performing neonatal or pediatric resuscitation according to published guidelines is challenging for health care teams. Audiovisual recordings of real neonatal resuscitations by NRP-trained delivery teams have found clinically significant errors in patient assessment, PPV, and chest compressions.[43] Observations of PALS-trained residents managing a high-fidelity simulation of pVT found errors in starting compressions within 1 min of pulselessness, never starting compressions, and not defibrillating in $\leq$3 min after the onset of pVT.[44]

Additional training opportunities should be offered outside the standard NRP and PALS courses where health care teams are expected to maintain both neonatal and pediatric resuscitation skills. One option is in situ simulation-based training.[45] Another option is high-frequency, low-dose booster training.[45] Additionally, training sessions on PPV, chest compressions, and other technical skills using deliberate practice with a mastery learning approach should be considered.[45] Monitoring resuscitation team performance through chart audits or clinical debriefing can help identify specific high-yield opportunities for improvement.

The Cost of Training Health Care Teams in Both NRP and PALS

As noted by Doroba, maintaining both NRP and PALS provider status can be expensive and time-consuming.[16] These costs can be prohibitive for health care systems that employ hundreds of nurses, physicians, respiratory therapists, and other team members. In estimating training costs, the direct costs of course attendance (registration fees and books) and the indirect costs of salary and benefits paid to the employee while attending the course must be considered.

Some centers have attempted to overcome the challenges in crosstraining in both NRP and PALS by developing custom-made courses. For example, Harer et al reported a model where only nursing leaders in the NICU received formal PALS training.[15] A separate "Mini PALS" course was developed for other nurses. The Mini PALS course was given during nursing annual education sessions. Nurses also completed brief hands-on bedside simulations to practice PALS skills. Although this approach may be cost-effective, the outcomes of such training are unknown.

KNOWLEDGE GAPS AND FUTURE DIRECTIONS

Resuscitation science has advanced significantly in the past few decades.[10,11] Although scientific advancements have led to improvements in neonatal and pediatric resuscitation guidelines, there is still much to learn about the resuscitation of hospitalized neonates and infants. The neonatal resuscitation guidelines acknowledge gaps in the optimal approach to resuscitating newborns in the NICU and other settings outside the delivery room.[10] The pediatric resuscitation guidelines cite knowledge gaps on the appropriate age and setting to transition from neonatal to pediatric resuscitation protocols and the optimal ventilation and chest compression rates during CPR.[11] The authors of this report identified several other knowledge gaps. More data are needed on the incidence and etiologies of IHCA of neonates and infants in the NICU, PICU, and PCICU and outside the ICUs. The best airway management methods and pediatric anesthesia providers' role for IHCA need further clarification. Studies are needed on the optimal resuscitation approach for extremely premature infants, neonates with sudden unexpected postnatal collapse, bronchopulmonary dysplasia, pulmonary hypertension, congenital heart disease, ductal physiology, shock, and other pathophysiologic states common in the ICU. Finally, long-term, outcomes-based research is needed to explore the impact of using different resuscitation approaches on hospitalized neonates and infants.

CONCLUSIONS

The lack of robust scientific data makes it impossible to provide definitive recommendations on when to transition from neonatal to pediatric resuscitation guidelines for hospitalized neonates and infants. In this report, we have provided an overview and summary of the existing neonatal and pediatric guidelines and described some potential approaches to consider when addressing this issue. This report is intended for general consideration, is based primarily on expert opinion and clinical experience, and will not apply to all circumstances. Therefore, it is up to health care teams and institutions to decide if neonatal or pediatric guidelines are the best choice in a given location or situation. Each center and health system must determine its approach to the resuscitation of hospitalized neonates and infants, considering local circumstances, health care team preferences, and resource limitations.

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ABBREVIATIONS

AAP: American Academy of Pediatrics
AHA: American Heart Association
CPR: cardiopulmonary resuscitation
NRP: neonatal resuscitation program
PALS: pediatric advanced life support
PCICU: pediatric cardiac intensive care unit
pVT: pulseless ventricular tachycardia
VF: ventricular fibrillation

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