

Does History of Prematurity Prompt Blood Pressure Evaluations at Primary Care Visits?

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Abstract

Prematurity is a risk factor for elevated blood pressure (BP). We performed a mixed-methods study of care patterns and awareness of early BP screening recommendations for infants born prematurely (IBP) by interviewing/surveying providers on practice- and provider-level BP screening. IBP's records were reviewed for BP screening documentation, demographics, and gestational age (GA). Visits <33 months were reviewed for anthropometrics, BP, and comorbidities. Chi-square analysis evaluated BP screening by GA and comorbidities. Twenty-six of 49 practices completed interviews; 81% had infant BP equipment available; 4% had BP measurement protocol for IBP. Twenty-eight of 86 providers were aware of screening guidelines; none reported routine assessment. Twenty-eight of 118 IBP had ≥1 BP documented; 43% had BP ≥90th percentile. Screening did not differ by GA group. Kidney-related diagnosis was associated with more frequent BP screening ($P = .0454$). BP is not routinely measured though often elevated before age 3 in IBP.

Keywords

hypertension, children, outpatient, prematurity, screening

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Introduction

Approximately 10% of infants in the United States are born preterm, prior to 37 weeks gestational age (GA).¹ Prematurity imparts an increased risk for many serious health conditions including elevated blood pressure (BP) and overt hypertension.^{2,3} Recent literature suggests that elevated BP in infants born prematurely (IBP) is a precursor for hypertension in childhood and adolescence, although the exact prevalence of this condition remains unknown.⁴⁻⁹ Among the most recognized risk factors for hypertension in IBP are reduced nephron mass, umbilical artery catheterization, and acute kidney injury.¹⁰⁻¹⁵

In light of the long-term health implications, recommendations exist to promote early diagnosis of hypertension in the primary care setting among children born prematurely. The 2004 Fourth Report on the Diagnosis, Evaluation, and Treatment of High Blood Pressure in Children and Adolescents recommended to measure BP in children younger than 3 years of age who have a history of prematurity during health care visits.¹⁶ Acknowledging the risk for hypertension and the need

for BP monitoring, the American Academy of Pediatrics (AAP) revised its clinical practice guidelines in 2008 to include BP screening in children younger than 3 years of age with history of prematurity¹⁷ and further updated these guidelines in 2017.¹⁸ In the 2017 guideline, children younger than 3 years should have BP measured if they were born earlier than 32 weeks of GA, are small for GA, have very low birth weight, or have other neonatal complications requiring intensive care including umbilical artery catheterization.^{15,18,19}

Despite these recommendations, there is no research that evaluates pediatrician compliance or practice

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readiness to comply with the BP screening guidelines. We set out to study the capabilities and provider awareness of the 2008 AAP guideline to measure BP in children younger than 3 years old with a history of premature birth. We aimed to evaluate medical record documentation from primary care practices on screening and identification of elevated BP among patients who were born prematurely.

Methods

This was a mixed-methods descriptive study conducted between January and July of 2016, in a pediatric practice-based research network, the Pediatric Practice Research Group (PPRG). At the time of the study, the PPRG had 49 primary care pediatric and multispecialty (eg, family medicine and pediatric) practices in the Chicago metropolitan area. The PPRG is led by researchers at the Ann & Robert H. Lurie Children's Hospital of Chicago (Lurie Children's Hospital) and Northwestern University's Feinberg School of Medicine.²⁰ Fifteen participating PPRG practices have established Federal Wide Assurances and Inter-institutional Agreements with the Lurie Children's Hospital Internal Review Board (IRB) and completed Business Associate Agreements with Lurie Children's Hospital, which allowed the hospital and PPRG staff members to either conduct record reviews at practice sites or obtain data downloads from the practices for IRB-approved and practice-approved studies. For practices without those agreements, individual providers conducted chart reviews.

All PPRG practices were invited to participate in the study. These practices only provide primary care and do not have neonatal intensive care unit follow-up clinics. There were 3 main study components: first, a key practice member/clinician was asked to complete a semistructured interview (either on the phone or in-person) to gain understanding on BP screening practices for infants. Questions assessed availability of infant BP equipment or infant BP cuff (bladder size 6 cm × 12 cm), existence of BP screening protocols, work flow related to BP measurement including who obtained the BP and how it was interpreted, perceived frequency of obtaining BP in infants, and willingness to participate in a medical record review of BP documentation. Responses from the interviews were compiled, and frequency of survey responses was obtained.

Second, PPRG providers (physicians, physician assistants, and advance practice nurses) were also invited to participate in a web-based survey distributed to their e-mail addresses via SurveyMonkey. Providers were invited to complete the survey regardless of practice participation in any other study component. The

survey assessed provider routines for BP screening of infants and knowledge of age- and risk-related BP screening recommendations. Survey responses were pooled to determine frequencies. Information derived from provider incentives was used to link providers with a practice.

As a third component, a patient medical record review was conducted among practices whose representative had agreed during the interview to participate in this aspect of the study. Records of eligible study subjects included those with history of premature birth, GA at birth <37 weeks (using the 2008 Guideline¹⁷ definition of preterm GA at which BP screening should be performed), and a date of birth between January 1, 2012, and June 30, 2013. Data on sex, race/ethnicity, insurance status, birth weight, GA, height, weight, BP, BP interpretation, BP-related diagnosis, and prematurity-related comorbidities from all available health visits between ages 0 and 33 months were obtained. We used 0- to 33-month visits to capture all visits between the newborn or initial office visit and visits that could be coded as well visit corresponding to age 30 months. Patient record data were obtained using 2 different strategies: manual review of electronic records or automated data downloads. To identify eligible study subjects, International Classification of Disease Versions 9 and 10 codes for prematurity (765.1; P07) were queried in the record. Searches also included the following key terms/notations: "use of Synagis," retinopathy of prematurity, apnea of prematurity; when patients with such codes were identified, a corroboration of subjects with a documented GA <37 weeks and visits up to 33 months of age was performed to ensure only IBP were included in the study.

The BP measurements were interpreted using the Report on the Second Task Force on Blood Pressure Control in Children—1987.²¹ Elevated BP was defined as any measurement ≥ 90 th percentile for age and sex. For those patients 12 months or older with a height measurement and BP measurement ≥ 90 th percentile of systolic and/or diastolic, we determined if the measurement was ≥ 90 th percentile using the National Heart, Lung, and Blood Institute BP reference tables available in the Fourth Report as these are thresholds for BP interpretation widely recognized and used by clinicians.¹⁶ We obtained frequency of elevated systolic or diastolic BP measurements. We also obtained the weight-for-length percentile for children with elevated BP and with documented height and weight measurements using the World Health Organization growth chart references.²² To categorize GA, we used the WHO cut points (moderate to late preterm 32 to <37 weeks, very preterm 28 to <32 weeks, and extremely preterm <28 weeks). Categorical

variables were reported as number (%), and continuous variables are reported as median and/or mean where appropriate. Fisher's exact tests evaluated frequency of BP measurement by GA group and differences in BP screening practices among patients with BP-related diagnoses and history of umbilical lines.

Ethics Approval and Informed Consent Statement

All study components were reviewed and approved by the Lurie Children's Hospital IRB. The IRB protocol #2016-192 was approved as a minimal risk study through an expedited review process. The protocol was approved with waiver of documentation of consent; the practice interview included verbal consent language, and the provider survey included a consent information sheet prior to the beginning of the survey. Waiver of informed consent and full Health Insurance Portability and Accountability Act (HIPPA) waiver were granted for the medical record review.

Results

Practice Interviews

A total of 26/49 (53%) practices completed the practice interview; most (24/26, 92%) of these interviews were conducted by phone with the rest being performed with an in-person site visit. Most practice respondents (21/26, 81%) reported having infant BP equipment. Of these, 19/21 (90%) reported on the type of equipment available: manual (9), automatic (9), or both (1). Interpretation of BP was obtained using an electronic reference in 50% (13/26) of the practices. Most practice respondents reported that their providers routinely obtain BP in children starting at 3 years of age, but respondents from 2 practices reported that their providers routinely measure BP on their patients when they are 2 years of age or older. Having a protocol in place for screening BP before 3 years of age was reported only at 1/25 practices (4%), and 19/25 (76%) practices reported that it would be up to the individual provider to decide if a BP screen was to be performed.

Provider Survey

There were 86/335 (26%) providers that completed the online provider survey; these providers represented 28 practices. Provider characteristics and survey responses are summarized in Figure 1 and Table 1.

Survey responses indicated that almost all, 75/85 (88%), providers reported being aware of the 2008 AAP

Bright Futures recommendation to begin routine BP screening and actually performing routine BP measurement at well visits of full-term children starting at 3 years of age. However, only a small group of respondents (28/86, 33%) were aware that BP screening is recommended at well visits of infants and toddlers with history of prematurity and no one reported routinely doing so, although most reported having available infant BP equipment at their practice.

Medical Record Review

Fifteen of the 26 practices (58%) in which the interview was completed agreed to participate in the medical record review. A total of 118 study subjects meeting inclusion criteria were identified, of which 58/118 (49%) were from the data download query and 60/118 were (51%) from the review of records. The median number of patients per practice was 7.0 (1-15), with demographic and patient characteristics shown in Table 2. Patients were classified as moderate to late preterm (60%), very preterm (21%), and extremely preterm (19%).

There were 966 records of visits from 118 eligible patients. BP was not documented in 829/966 (86%) of these records of visits in total. This represented no BP documentation for 86/118 (73%) of patients. Among the 29 patients with any BP documentation up to 33 months of age, 23 (79%) had measurements performed at least one well-child check comprising 63 discrete well visits; an additional 6 patients were identified with BP documentation at non-well visits despite having well visits at their primary care locations without BP screens performed. There was no significant difference in the proportion of BP measurements performed among the 3 GA groups ($P = .922$) as depicted in Table 3. Median age at time of first BP measurement was 29.6 (3.4-33.0) months. A majority (66%) of the BP measurements were not performed at the first office visit.

We found either a systolic, a diastolic, or both measures having a BP ≥ 90 th percentile in 43% (12/28) of patients. Five of the patients with elevated systolic BP also had elevated diastolic BP. The median weight-for-length percentile for the 11 patients with elevated BP and weight and height measurements was 73 (4-98); the mean was 59.8 (36.3). Among the 7 children 12 months or older that were found to have had an elevated BP measurement using the Second Report, all had elevated systolic BP and/or diastolic BP when using the 90th percentile of the Fourth Report. Documentation acknowledging elevated BP was found in the record of only one (14%) of these patients.

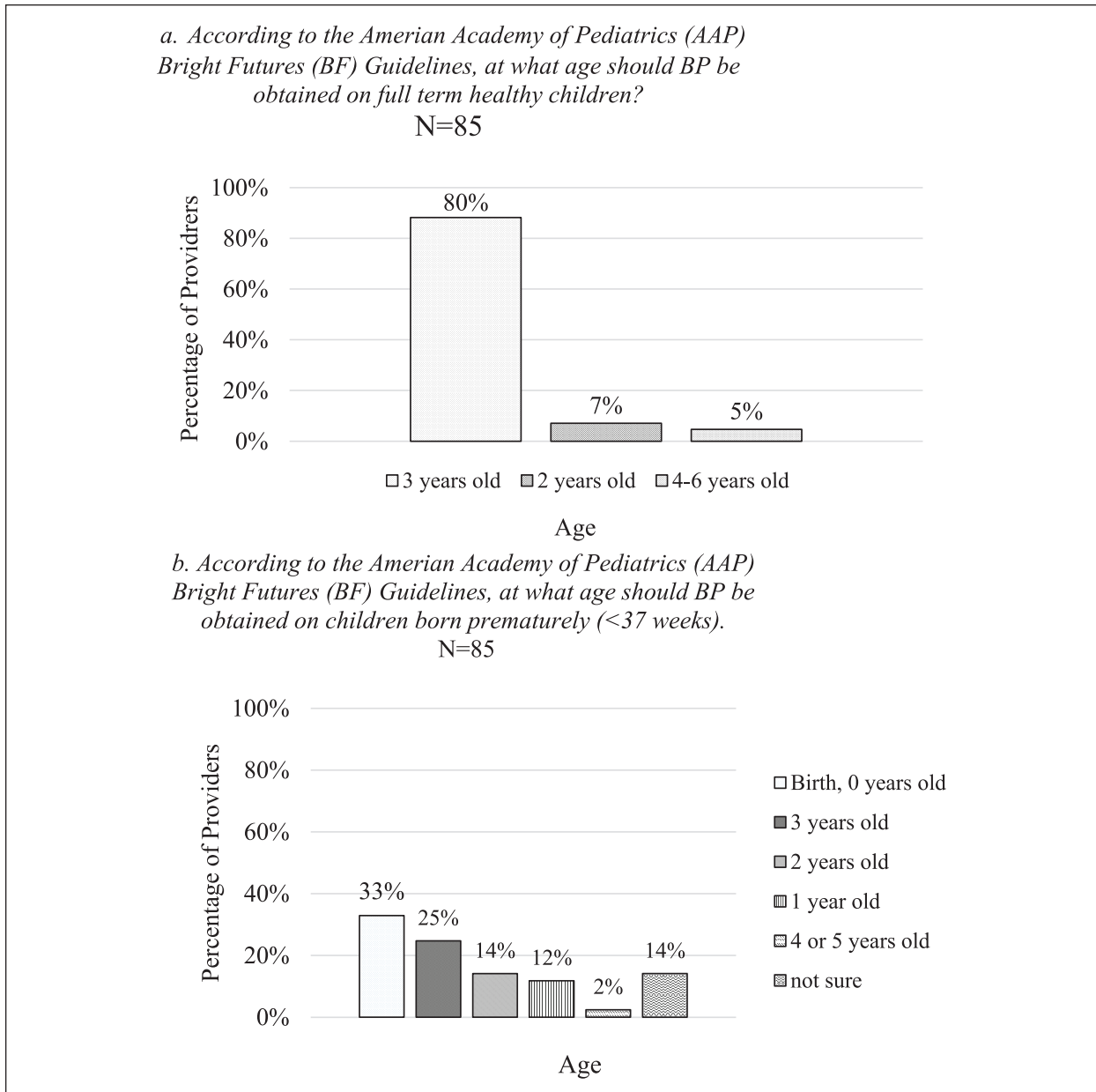


Figure 1. Provider-reported guideline knowledge: (a) for full-term healthy children; (b) for children born prematurely.

From the 118 identified patients, there were 25 patients (21%) with kidney-related conditions and/or history of umbilical lines. Of these, 6/25 patients had only a kidney-related diagnosis. Frequency of BP measurement documentation was significantly different among those with a kidney-related diagnosis, 4/6 (67%), versus those without such diagnosis, 28/112 (25%; Fisher's exact, $P = .0454$). Frequency of BP measurement documentation was not significantly affected by having a history of umbilical catheter placement (21%, positive history vs 28%, no history; $P = .587$).

Discussion

We conducted a comprehensive assessment of outpatient pediatric provider practices with regard to measuring BP in children younger than 3 years with history of prematurity. We found that the majority of practices interviewed had the appropriate BP equipment. This is encouraging since it has been previously reported among family practitioners that primary care settings were equipped with limited access to BP cuffs appropriately sized for infants.²³ The practice interview was intended

Table 1. Provider Characteristics and Survey Responses.

	n	%
Type of provider (N = 86)		
Pediatrician	79	92%
Other (APN, NP, family MD)	7	8%
Primary practice payor type (self-reported; N = 85)		
Private insurance	55	66%
Medicaid	28	33%
Self-pay	2	2%
Reported availability of infant BP cuff (N = 83)		
Yes (automatic and/or manual)	72	87%
No or not sure	11	13%
Provider reported care routines		
Obtaining BP during well-child check visits		
Full-term children ≥ 3 years of age, routinely (N = 84)	84	100%
Infants/toddlers born prematurely (N = 82)		
Sometimes or rarely	72	88%
Never	10	12%
Provider BP interpretation (N = 72)		
Provider reported interpretation frequency (always/almost always)	49	68%
Most frequently reported way to interpret BP		
Use reference tables from the NHLBI (eg, Harriet Lane tables)	30	42%
Rely on an automatic interpretation performed by EHR	18	25%
Reported provider action if BP is found to be elevated		
Repeat to verify at that visit	67	93%
Repeat to verify at a follow-up visit for BP management	59	82%
Repeat at the next well visit	20	28%
Refer to a specialist (eg, nephrologist, cardiologist)	32	44%

Abbreviations: APN, advanced practice nurse; NP, nurse practitioner; MD, Doctor of Medicine; BP, blood pressure; NHLBI, National Heart, Lung, and Blood Institute.

to serve a dual purpose—allow the first inquiry into a practice assessment while simultaneously engaging practices in a research topic they may not have otherwise considered of interest. Most surveyed providers were not aware of the 2008 guideline and their reported BP-related care routines for infants and toddlers born premature was not close to guideline compliance. The medical record review process indicated that most practices did not have a systematic method to identify prematurely born children and that despite a majority of participating practices having infant BP equipment, very few of the at-risk patients had their BP measured prior to 3 years of age. Additionally, even fewer have their BP measurements properly interpreted with a subsequent plan of care implemented in keeping with the implications of the measurement.

Our record review findings indicate that among children whose BP was measured, a majority had elevated BP, consistent with contemporary research demonstrating elevated BP in early school age children with history of prematurity.²⁴ This supports the concept of the need

for targeted screening of these at-risk children. Numerous factors related to the intrauterine and extra-uterine environment may increase the risk for hypertension in children born preterm.¹⁴ We found it intriguing that certain combinations of risk factors, such as a history of umbilical lines and/or a history of more significant prematurity was not associated with providers more attentively screening these infants and toddlers, whereas a diagnosis of hypertension or a kidney-related disorder was. This may indicate other factors contributing to decision-making in primary care that were not assessed as part of our study, such as having the involvement of a specialist who requested the targeted BP screening take place.

Given the frequency of well visits before 3 years and the recommendation for nonuniversal screening of infants and toddlers born prematurely, improving compliance with this AAP recommendation may involve a multidimensional approach. This could include implementing systematic ways to identify history of prematurity and the other neonatal-related factors that likely result in elevated

Table 2. Demographic and Patient Characteristics of Medical Record Review (N = 118).

	n	%
Participant gender		
Male	66	56%
Female	52	44%
Insurance type		
Private insurance (ie, HMO, PPO, etc)	61	52%
Medicaid/All Kids or other government-backed insurance	47	39%
Self-pay	1	1%
More than 1 type or other program	3	3%
Not documented	6	5%
Gestational age groups		
Extreme preterm (<28 weeks)	22	19%
Very preterm (28 to <32 weeks)	25	21%
Moderate preterm (32 to <37 weeks)	71	60%
Birth weight groups		
Extreme low birth weight	19	16%
Very low birth weight	23	19%
Low birth weight	60	51%
Normal weight	14	12%
Birth weight not documented	2	2%

Abbreviations: HMO, Health Maintenance Organization; PPO, Preferred Provider Organization.

Table 3. Rates of Blood Pressure Screening by Gestational Age Category.

Gestational Age Group	Screened, n (%)	Not Screened, n (%)
Extreme preterm	6 (27%)	16 (73%)
Very preterm	6 (24%)	19 (76%)
Late to moderate preterm	16 (23%)	55 (78%)
Total	28 (24%)	90 (76%)

BP. The solutions may include reminders in the electronic health record instead of relying primarily on provider discretion to access the information stored in the problem/diagnosis lists. It also may be possible that reducing the proposed frequency of screens to “lower the burden” on pediatric offices (the overwhelming majority of which do not have a protocol in place for such measurements) would increase the rate of BP screenings. Future studies could compare the BP screening outcomes of 2 approaches—annual screening starting at 12 months (age when the Fourth Report reference tables begin) and screening at every well visit before 3 years of age (as is currently recommended in Bright Futures).

The study importantly adds to the body of literature that infants and young children with history of prematurity have a nontrivial prevalence of BP elevation in

the outpatient pediatric setting that requires the attention of pediatric practitioners. Past research has indicated that elevated BP tracks from infancy onward² with biochemical differences in the renin-angiotensin-aldosterone profiles of adolescents with history of prematurity relative to their non-preterm peers.⁹ It is imperative that pediatric providers become aware of the implications of the history of negative factors from pregnancy and birth (eg, low birth weight and prematurity) on the cardiovascular health outcome of children. Raising the awareness of this relationship may increase the level of attention that is needed to achieve changes in care behaviors, as an improved understanding of the impact of performing the BP screening may help define the importance of following the recommended guidelines.

Providers appeared optimistic that educational initiatives targeting outpatient pediatric practitioners regarding BP screening recommendations may be effectively implemented. Further research is needed assessing whether an educational intervention leads to sustainable change or whether other avenues such as improving hand-off communication or embedding other alerts in the health record would be more effective methodologies.

Future research should also focus not only on strategies to improve outpatient providers’ adherence with BP screening recommendations for infants and toddlers with history of prematurity, but also with determining a periodicity schedule that balances feasibility with necessity for all infants and young children at risk for early hypertension. Additionally, the difficulties associated with interpreting infants’ and toddlers’ BP remains an ongoing challenge for primary care providers who perform these targeted screens.

Our study had several limitations. First, we were limited by both the number of practices and providers with which we were able to successfully engage. We suspect that practices interviewed as well as provider respondents may be biased as practices and providers that have the appropriate BP equipment may be more likely to share this information with study staff. Individual providers may also have been subject to reporter bias in assessing their own practices’ procedures for measuring BP. The medical record review has the limitation of the retrospective nature. We used the parent report of GA from pediatrician notes. Exact GA data are unfortunately not fully available. Specific documentation of episodes of acute kidney injury were not available, though we have done our best to take note of patients where a kidney-related diagnosis was documented. We do not have the ability to determine exactly why any individual patient had a BP screen done, and

given that many outpatient providers perform screens and tests at the request of consultants or due to discharge instructions from the neonatal intensive care unit, it is possible that our assessment of the incidence of elevated BP readings is higher than it would be for the preterm population in general. Additionally, when BP was measured, its elevation could have been due to a nonmedical reason such as the patient crying at the time of the measurement being obtained. We also were unable to determine if BP measurement was attempted, but efforts were abandoned due to poor cooperation on the part of the patient. It does, however, remain informative that in the vast majority of cases, these screens simply are not taking place.

Conclusions

Most pediatric providers do not routinely check BP prior to 3 years of age in patients born prematurely, despite having the proper equipment. Most practices do not have a protocol in place for measuring BP in premature infants, and the decision to perform this screen is usually left to the provider at the visit. It is evident that new systems are needed to identify and prompt BP screening at primary care visits of children with a history of prematurity. These findings would need to be replicated in a large number of practices.

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Author Contributions

BDK: Contributed to conception or design; contributed to acquisition, analysis, or interpretation; drafted the manuscript; critically revised the manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring integrity and accuracy.

GF: Contributed to conception or design; contributed to acquisition, analysis, or interpretation; critically revised the manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring integrity and accuracy.

LEB: Contributed to conception or design; contributed to acquisition, analysis, or interpretation; critically revised the manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring integrity and accuracy.

LB: Contributed to acquisition, analysis, or interpretation; critically revised the manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring integrity and accuracy.

AJA: Contributed to conception or design; contributed to acquisition, analysis, or interpretation; drafted the manuscript; critically revised the manuscript; gave final approval; agrees to be accountable for all aspects of work ensuring integrity and accuracy.

Declaration of Conflicting Interests

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