

Length of Stay and Complications Associated With Febrile Infants <90 Days of Age Hospitalized in the United States, 2000-2012: A Commentary

Soha Shah, MD, Samantha J. Bapty, MD, Eric A. Biondi, MD, MS

Zangwill et al¹ present a statistically rigorous study designed to evaluate whether there was a change in length of stay (LOS) for young, febrile infants hospitalized for evaluation between 2000 and 2012. Using a national data set, in combination with state agencies' discharge databases, the authors of this study retrospectively analyzed LOS, risk factors for prolonged LOS, complications, and results of viral testing of >40 000 infants <90 days of age. The authors conclude that LOS for febrile infants did not change significantly during this 12-year period. This was contrary to their hypothesis that changes in epidemiology of bacterial infections and increased use of viral testing should have led to a decrease in LOS for these infants. The authors conclude that "targeted effort to raise awareness and implications of these issues in the care of inpatients"¹ is needed.

If the authors' hypothesis is correct (that LOS should have decreased and did not), our field has work to do. If we have failed to appropriately shorten LOS in a population deserving of it, then we are falling short of adequately using the tools and knowledge at our disposal to meaningfully adapt our practice, which would be concerning. However, we must critically assess the 2 points made by the authors with regard as to why a shorter LOS was hypothesized for well-appearing, febrile infants: (1) a decrease in prevalence of bacterial infections in this patient population and (2) changes in the use of viral testing.

The authors operate under the assumption that the epidemiology of serious bacterial infection (SBI) has changed and that prevalence has decreased, suggesting that this, in turn, should result in shortened LOS. Although changes in epidemiology have been fairly strongly supported in the literature over the past decades, such as a decline in the proportion of infections caused by *Listeria monocytogenes* and rise in the proportion of those caused by *Escherichia coli*,²⁻⁵ variations in causative organisms do not necessarily mean that the overall prevalence of SBI has changed. In fact, there is a paucity of data to support the assertion that the overall prevalence of bacterial meningitis and/or bacteremia (the 2 occult bacterial infections for which these infants generally remain hospitalized pending culture results and evaluation) declined during the study period. For example, with regard to invasive infections caused by late-onset group B *Streptococcus* (after 72 hours of life), prevalence was stable at 0.3 cases per 1000 live births from 2000 to 2012.⁶ Similarly, rates of invasive infections from *Haemophilus influenzae*

www.hospitalpediatrics.org

DOI: <https://doi.org/10.1542/hpeds.2018-0200>

Copyright © 2018 by the American Academy of Pediatrics

Address correspondence to Eric A. Biondi, Department of Pediatrics, Johns Hopkins Children's Center, 9318 Perry Hall, Baltimore, MD 21128. E-mail: ebiondi2@jhmi.edu

HOSPITAL PEDIATRICS (ISSN Numbers: Print, 2154-1663; Online, 2154-1671).

FINANCIAL DISCLOSURE: The authors have indicated they have no financial relationships relevant to this article to disclose.

FUNDING: No external funding.

POTENTIAL CONFLICT OF INTEREST: The authors have indicated they have no potential conflicts of interest to disclose.

Drs Shah and Bapty drafted the initial manuscript with equal contribution and participated in revision of the manuscript; Dr Biondi reviewed and revised the initial manuscript; and all authors approved the final manuscript as submitted.

Opinions expressed in these commentaries are those of the authors and not necessarily those of the American Academy of Pediatrics or its Committees.

Department of Pediatrics,
Johns Hopkins Children's
Center, Baltimore,
Maryland

have not significantly changed over this time period.⁶ Although we found few studies in which researchers examined the prevalence of bacteremia or meningitis in well-appearing infants during the authors' study period, since the early 1990s, the rate of bacteremia in infants presenting with fever without a source has been shown to be consistently between 1% and 4% regardless of the year of data collection, and a similar story is found in bacterial meningitis, for which the rate has generally been <1.5% over the previous decades.^{7–14} The theory that prevalence of SBI, specifically bacteremia and meningitis, decreased from 2000 to 2012 does not appear to be supported in the literature.

With regard to whether changes in viral testing should have resulted in a shortened LOS during the study period, this really is not as simple as stating that more viral testing was likely available, so more testing should have been done, and LOS should have been shortened on the basis of the results of this testing. Over the past 10 to 15 years, the use of polymerase chain reaction and nucleic acid tests allowed more timely and accurate detection of a variety of viral illnesses.¹⁵ However, it is not clear to what extent these tests were available, and if they were available, whether results would have returned rapidly enough to impact LOS. It is also not clear, or at least it was not clear a decade ago, how these tests should be used by providers to influence LOS. Although it is generally accepted that febrile infants with a documented viral infection are less likely to have a concurrent SBI than other febrile infants,^{16,17} the first large-scale data in which researchers incorporated these tests into a clinical algorithm for febrile infant management were not published until after the authors' data collection period.¹⁸

The authors speculate that viral testing might have been limited by personal factors such as experience, practice patterns, or medicolegal concerns. This is possible, although it has also been suggested that clinicians may be less likely to admit to the hospital or use antimicrobial agents on well-appearing febrile infants with an identified respiratory virus.¹⁹ It may also

have been that respiratory viral testing simply was not available during the study years at many of these institutions or that the turnaround time for this testing was prohibitive, such that it did not meaningfully impact LOS, particularly if this testing had to be sent to an outside laboratory. We agree with the authors that appropriate use of viral testing may be a path toward reducing LOS, particularly as others have identified a viable model for incorporating viral testing into the evaluation of a febrile infant.¹⁸ However, it is not clear to what extent viral testing had been incorporated into clinical algorithms and practice over the course of the study time frame, nor is it clear that providers knew what to do with a positive test result, so it seems unfair to suggest that viral testing should have resulted in a decreased LOS from 2000 to 2012 for these infants. It may be likely that today respiratory viral testing is used much more frequently to impact LOS, but the data from the study by Zangwill et al¹ are older and were collected at a time during which many of the tests used today were being developed, thus limiting the conclusions we can draw.

Finally, it should be noted that we know of no new widely used guidelines for well-appearing, febrile infant management published during the study period, but several have been published since, suggesting that the incorporation of viral testing into febrile infant management took some time and may now be different from what it was from 2000 to 2012.^{18,20}

We agree with the authors that this is an area of interest in our continued efforts to provide cost-effective, evidence-based care to this population, but we contend that the time period of their study makes it difficult to draw reliable conclusions regarding the reasons behind the lack of change in LOS. The evidence base used to support best practice for these infants is stronger now than it was in the early and mid-2000s. Additionally, viral testing is more sophisticated, and the use of such testing is better understood. Since 2012, comprehensive national and local quality improvement efforts have targeted this patient population, and today, hypothesizing

an appreciable decline in LOS would be justified. If this study is repeated by examining data from 2012 to 2018 and researchers identify similar results, then the authors' conclusions about additional quality improvement efforts and evidence-based interventions would be justified.

REFERENCES

1. Zangwill K, Nguyen D, Friedlander S, Fleischman R. Length of stay and complications associated with febrile infants <90 days of age hospitalized in the United States, 2000–2012. *Hosp Pediatr*. 2018;8(12)
2. Lee B, Newland JG, Jhaveri R. Reductions in neonatal listeriosis: “collateral benefit” of Group B streptococcal prophylaxis? *J Infect*. 2016;72(3):317–323
3. Biondi E, Evans R, Mischler M, et al. Epidemiology of bacteremia in febrile infants in the United States. *Pediatrics*. 2013;132(6):990–996
4. Greenhow TL, Hung YY, Herz AM, Losada E, Pantell RH. The changing epidemiology of serious bacterial infections in young infants. *Pediatr Infect Dis J*. 2014;33(6):595–599
5. Mischler M, Ryan MS, Leyenaar JK, et al. Epidemiology of bacteremia in previously healthy febrile infants: a follow-up study. *Hosp Pediatr*. 2015;5(6):293–300
6. Centers for Disease Control and Prevention. Active bacterial core surveillance reports 1997–2016. Available at: www.cdc.gov/abcs/reports-findings/surv-reports.html. Accessed October 19, 2018
7. Ferrera PC, Bartfield JM, Snyder HS. Neonatal fever: utility of the Rochester criteria in determining low risk for serious bacterial infections. *Am J Emerg Med*. 1997;15(3):299–302
8. Baker MD, Bell LM. Unpredictability of serious bacterial illness in febrile infants from birth to 1 month of age. *Arch Pediatr Adolesc Med*. 1999;153(5):508–511
9. Herr SM, Wald ER, Pitetti RD, Choi SS. Enhanced urinalysis improves identification of febrile infants ages

- 60 days and younger at low risk for serious bacterial illness. *Pediatrics*. 2001;108(4):866–871
10. Bachur RG, Harper MB. Predictive model for serious bacterial infections among infants younger than 3 months of age. *Pediatrics*. 2001;108(2):311–316
 11. Bonsu BK, Chb M, Harper MB. Identifying febrile young infants with bacteremia: is the peripheral white blood cell count an accurate screen? *Ann Emerg Med*. 2003;42(2):216–225
 12. Caviness AC, Demmler GJ, Almendarez Y, Selwyn BJ. The prevalence of neonatal herpes simplex virus infection compared with serious bacterial illness in hospitalized neonates. *J Pediatr*. 2008; 153(2):164–169
 13. Zarkesh M, Hashemian H, Momtazbakhsh M, Rostami T. Assessment of febrile neonates according to low risk criteria for serious bacterial infection. *Iran J Pediatr*. 2011;21(4):436–440
 14. Baraff LJ, Bass JW, Fleisher GR, et al; Agency for Health Care Policy and Research. Practice guideline for the management of infants and children 0 to 36 months of age with fever without source. *Ann Emerg Med*. 1993;22(7): 1198–1210
 15. Advani S, Sengupta A, Forman M, Valsamakis A, Milstone AM. Detecting respiratory viruses in asymptomatic children. *Pediatr Infect Dis J*. 2012; 31(12):1221–1226
 16. Titus MO, Wright SW. Prevalence of serious bacterial infections in febrile infants with respiratory syncytial virus infection. *Pediatrics*. 2003;112(2): 282–284
 17. Byington CL, Enriquez FR, Hoff C, et al. Serious bacterial infections in febrile infants 1 to 90 days old with and without viral infections. *Pediatrics*. 2004;113(6): 1662–1666
 18. Byington CL, Reynolds CC, Korgenski K, et al. Costs and infant outcomes after implementation of a care process model for febrile infants. *Pediatrics*. 2012; 130(1). Available at: www.pediatrics.org/cgi/content/full/130/1/e16
 19. Burstein B, Dubrovsky AS, Greene AW, Quach C. National survey on the impact of viral testing for the ED and inpatient management of febrile young infants. *Hosp Pediatr*. 2016;6(4): 226–233
 20. Mintegi S, Bressan S, Gomez B, et al. Accuracy of a sequential approach to identify young febrile infants at low risk for invasive bacterial infection. *Emerg Med J*. 2014;31(e1): e19–e24

Length of Stay and Complications Associated With Febrile Infants <90 Days of Age Hospitalized in the United States, 2000-2012: A Commentary

Soha Shah, Samantha J. Bapty and Eric A. Biondi

Hospital Pediatrics 2018;8;796

DOI: 10.1542/hpeds.2018-0200 originally published online November 27, 2018;

Updated Information & Services	including high resolution figures, can be found at: http://hosppeds.aappublications.org/content/8/12/796
Supplementary Material	Supplementary material can be found at:
References	This article cites 17 articles, 8 of which you can access for free at: http://hosppeds.aappublications.org/content/8/12/796#BIBL
Subspecialty Collections	This article, along with others on similar topics, appears in the following collection(s): Epidemiology http://www.hosppeds.aappublications.org/cgi/collection/epidemiology_sub Hospital Medicine http://www.hosppeds.aappublications.org/cgi/collection/hospital_medicine_sub Infectious Disease http://www.hosppeds.aappublications.org/cgi/collection/infectious_diseases_sub
Permissions & Licensing	Information about reproducing this article in parts (figures, tables) or in its entirety can be found online at: http://www.hosppeds.aappublications.org/site/misc/Permissions.xhtml
Reprints	Information about ordering reprints can be found online: http://www.hosppeds.aappublications.org/site/misc/reprints.xhtml

Hospital Pediatrics®

AN OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Length of Stay and Complications Associated With Febrile Infants <90 Days of Age Hospitalized in the United States, 2000-2012: A Commentary

Soha Shah, Samantha J. Bapty and Eric A. Biondi

Hospital Pediatrics 2018;8;796

DOI: 10.1542/hpeds.2018-0200 originally published online November 27, 2018;

The online version of this article, along with updated information and services, is located on the World Wide Web at:

<http://hosppeds.aappublications.org/content/8/12/796>

Hospital Pediatrics is the official journal of the American Academy of Pediatrics. A monthly publication, it has been published continuously since 1948. Hospital Pediatrics is owned, published, and trademarked by the American Academy of Pediatrics, 345 Park Avenue, Itasca, Illinois, 60143. Copyright © 2018 by the American Academy of Pediatrics. All rights reserved. Print ISSN: 1073-0397.

American Academy of Pediatrics

DEDICATED TO THE HEALTH OF ALL CHILDREN®

