Frequency and Consequences of Routine Temperature Measurement at Well-Child Visits

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OBJECTIVES: To determine the (1) frequency and visit characteristics of routine temperature measurement and (2) rates of interventions by temperature measurement practice and the probability of incidental fever detection.

METHODS: In this retrospective cohort study, we analyzed well-child visits between 2014–2019. We performed multivariable regression to characterize visits associated with routine temperature measurement and conducted generalized estimating equations regression to determine adjusted rates of interventions (antibiotic prescription, and diagnostic testing) and vaccine deferral by temperature measurement and fever status, clustered by clinic and patient. Through dual independent chart review, fever (≥100.4°F) was categorized as probable, possible, or unlikely to be incidentally detected.

RESULTS: Temperature measurement occurred at 155,527 of 274,351 (58.9%) well-child visits. Of 24 clinics, 16 measured temperature at >90% of visits (“routine measurement clinics”) and 8 at <20% of visits (“occasional measurement clinics”). After adjusting for age, ethnicity, race, and insurance, antibiotic prescription was more common (adjusted odds ratio: 1.21; 95% CI 1.13–1.29), whereas diagnostic testing was less common (adjusted odds ratio: 0.76; 95% CI 0.71–0.82) at routine measurement clinics. Fever was detected at 270 of 155,527 (0.2%) routine measurement clinic visits, 47 (17.4%) of which were classified as probable incidental fever. Antibiotic prescription and diagnostic testing were more common at visits with probable incidental fever than without fever (7.4% vs 1.7%; 14.8% vs 1.2%; P < .001), and vaccines were deferred at 50% such visits.

CONCLUSIONS: Temperature measurement occurs at more than one-half of well-child visits and is a clinic-driven practice. Given the impact on subsequent interventions and vaccine deferral, the harm–benefit profile of this practice warrants consideration.

WHAT’S KNOWN ON THIS SUBJECT: We recently reported that routine temperature measurement occurs at half of well-child visits nationally. Drivers and implications of this practice are unclear.

WHAT THIS STUDY ADDS: Temperature was measured at 59% of well-child visits; some clinics measured temperature routinely, and others measured only occasionally. The practice triggered more antibiotic prescriptions, less diagnostic testing, and detection of incidental fever, which was associated with increased interventions and vaccine deferral.

Well-child visits are the most common reason children present to ambulatory care.1 “Bright Futures,” the American Academy of Pediatrics preventive care guidelines, provides recommendations on health supervision, anticipatory guidance, and disease and developmental screening for well-child visits from birth through adolescence.2 It recommends 7 well-child visits within the first year of life, 5 between the ages of 1-3, then annually through adolescence.2 Although recommendations are made for other vital signs, temperature measurement guidelines are not included.2

Our previous study, using publicly available national survey data (the National Ambulatory Medical Care Survey), reported that temperature is measured at almost one-half of all well-child visits.3 The utility of routine measurement in asymptomatic children at well-child visits has yet to be determined and may have untoward consequences, such as reduced clinic efficiency, patient anxiety, and amplification of “fever phobia” (defined as exaggerated concerns about the harms of fever).4 Additionally, incidental detection of elevated temperatures through routine measurement may drive “overdiagnosis” or the diagnosis of abnormalities that do not benefit the patient by being detected.5 In our National Ambulatory Medical Care Survey study, we found that antibiotics and radiographs were more frequently ordered at visits in which temperature was measured, even in the absence of fever.3 Because of limitations of these data, we were unable to determine if clinic protocols and patient symptoms contribute to temperature measurement.

To address this gap, we analyzed electronic medical record (EMR) data from well-child visits at a network of primary care clinics to determine: (1) the frequency of routine temperature measurement and associations with patient and clinic characteristics and (2) the probability of detecting incidental fever and rates of interventions by temperature measurement practice and incidental fever detection.

**METHODS**

**Study Design and Data Source**

In this retrospective cohort study, we used well-child visit data from the Stanford Research Repository.5 The Stanford Research Repository contains EMR data from Stanford University hospitals and clinics beginning in May 2014 and includes detailed provider and department information, billing codes, patient demographics, and clinical details such as vital signs, diagnoses, diagnostic testing, and medication prescriptions. The Stanford University Institutional Review Board approved the investigation.

**Study Population**

We included well-child visits for children ≤18 years old seen between May 2014 and June 2019 at the Packard Children’s Health Alliance, a network of 24 Stanford-affiliated primary care clinics located throughout the northern California Bay Area. Because of the many potential Current Procedural Terminology and International Classification of Diseases (ICD) codes associated with well-child visits, well-child visits were identified by a field called “visit type” to differentiate preventive care visits from urgent care visits. To determine specificity of the data pull, we performed a random chart review on 30 visits in which a preventive care ICD-code was the primary diagnosis and 30 visits in which a preventive care ICD-code was a secondary diagnosis. All 60 notes were consistent with well-child visits (100% specificity). To assess whether visits were scheduled to address acute concerns but transitioned to well-child visits because the child was due for one, we also reviewed 20 visits scheduled within 3 days of the appointment. All notes were consistent with well-child visits. For aim 1, all well-child visits were included (n = 274 351). For aim 2, we excluded 64 (0.02%) visits with temperature values <94°F and 3 (0.001%) visits with temperatures >105°F, because, after chart review, these values were deemed to be likely inaccurately documented.

**Outcomes and Covariates**

**Temperature Measurement**

Temperature measurement was defined as the presence or absence of a temperature value in the vital signs section of the EMR. On preliminary analysis, we observed that clinics either measured temperatures at nearly all (>90%) well-child visits or at few (<20%) visits (Fig 1). Therefore, we categorized clinics as “routine measurement” or “occasional measurement,” respectively. We investigated differences in patient demographics between routine measurement and occasional measurement clinics.

**Incidental Fever**

We defined “incidental fever” as fever (temperature ≥100.4°F [≥38.0°C]) not previously suspected and thus, would not have been detected if not for routine temperature measurement. Because this is a subjective attribution, we classified incidental fevers as “probable” (ie, documentation in the progress note that fever was noted incidentally), “possible” (ie, no mention of preceding symptoms or chief complaint that may explain fever), or “unlikely” (ie, explicit documentation of concern that patient had infectious symptoms...
and/or fever preceding the encounter. The rubric is included in Supplemental Table 4, and examples of each classification are listed in Supplemental Table 5. “Probable” incidental fever was further classified into “noticed” or “unnoticed.” Visits with “unnoticed” fevers lacked mention of fever in the progress note (except for as a listed vital sign) and were not associated with interventions commonly linked to fever, including vaccine deferral. To classify fever, 2 of 5 board-certified pediatricians (AP, AS, MW, JM, and RD) reviewed each chart associated with fever. We a priori set a Fleiss-Cohen weighted κ at 0.80 agreement and modified the rubric until this level was achieved. Disagreements between the 2 reviewers were resolved by team consensus.

Interventions

Interventions were defined as those commonly obtained in the management of febrile pediatric patients and included diagnostic tests (C-reactive protein [CRP], complete blood cell count [CBC], rapid influenza swab, rapid strep throat swab, and urine culture) and antibiotic prescriptions. In preliminary analysis, we discovered that some clinics obtained urinanalysis more frequently (~20% of all well-child visits) than expected, so we limited our urinary tract infection testing variable to urine cultures. For well-child visits with fever, we also described rates of and reasons for vaccine deferral. Examples of reasons for deferral are listed in Supplemental Table 6. Deferral was defined as explicit progress note wording to delay vaccination. For patients who had vaccines deferred, we reviewed subsequent well-child visit notes to determine if the deferred vaccines were given.

Post Hoc Survey

Based on our preliminary findings that the practice of temperature measurement at well-child visits may be clinic driven, we decided to conduct an informal post hoc survey of the clinic managers via Qualtrics to better elucidate protocols surrounding temperature measurement. Survey questions are detailed in Supplemental Information.

Data Analysis

We first determined the frequency of temperature measurement at all well-child visits and examined how patient characteristics differed between routine measurement versus occasional measurement clinics. Bivariate and multivariable logistic regressions were performed to identify patient characteristics associated with being seen at routine measurement versus occasional measurement clinics, and odds ratios (ORs) with 95% confidence intervals (CIs) were calculated. We also calculated standardized mean differences (SMDs) to evaluate the magnitude of the differences in patient characteristics, using cutoffs previously defined by Cohen: no difference if SMD was <0.2, small if SMD was 0.2–0.49, moderate if SMD was 0.5–0.79, and large if SMD was 0.8–1.

To determine the impact of routine temperature measurement and incidental fever detection, we used χ² statistics and a generalized estimating equations regression to compare rates of interventions pursued at routine measurement versus occasional measurement clinics and at visits with fever versus without fever among visits in which temperature was measured at routine measurement clinics. Our multivariable model adjusted for patient characteristics determined to have moderate and large differences (SMD: ≥0.5) between routine measurement and occasional measurement clinics (age, ethnicity, race, and primary insurance) and accounted for clustering by clinic and patient. Because preliminary findings revealed that providers at each clinic did not deviate from overall clinic practice regarding temperature measurement, we did not account for clustering by provider.

Because incidental fever is a subjective attribution, we performed a sensitivity analysis to compare rates of interventions at visits with...
different categories of incidental fever to rates of interventions at visits lacking fever. Because of a low number of patients within each category, this sensitivity analysis was an unadjusted descriptive analysis. We performed chart review on well-child visits with documented fever for infants ≤90 days of age to better understand the impact of capturing incidental fever in this cohort, who are at higher risk for missing serious bacterial infection in the setting of fever. All analyses were conducted by using R 4.0.3 (R Foundation for Statistical Computing, Vienna, Austria).

RESULTS
We analyzed a total of 274 351 well-child visits in 50 571 children. Temperature was measured at 161 639 (58.9%) well-child visits. A total of 16 of the 24 clinics (67%) measured temperature at >90% of well-child visits, and the remaining 8 clinics (33%) measured temperature at <20% of well-child visits (Fig 1).

Characteristics of Children Seen at Routine Measurement and Occasional Measurement Clinics
Table 1 displays characteristics of patients at routine measurement versus occasional measurement clinics. The mean patient age for both groups was 5 years old. Routine measurement clinics had a lower proportion of visits for neonates and higher proportions of visits for Hispanic or Latinx, Black, and “other” race patients and patients with government insurance than occasional measurement clinics.

In multivariable analysis, Black patients and patients with government insurance were more commonly seen than White patients and patients with private insurance, respectively, at both routine measurement and occasional measurement clinics. The ORs for these characteristics were higher for routine measurement clinics.

Post Hoc Survey
A total of 8 of 9 (89%) clinic managers representing the 24 ambulatory clinics responded to our post hoc informal survey. The survey revealed that some clinics routinely measure temperature at

### TABLE 1 Patient Characteristics at Routine Measurement and Occasional Measurement Clinics

<table>
<thead>
<tr>
<th>Patient Characteristics</th>
<th>Patients Seen at Occasional Measurement Clinics (N = 114 532), n (%)</th>
<th>Patients Seen at Routine Measurement Clinics (N = 159 819), n (%)</th>
<th>Unadjusted OR (95% CI)</th>
<th>Multivariable OR (95% CI)bc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age category</td>
<td>(   )</td>
<td>(   )</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>0–30 d</td>
<td>5971 (5.2)</td>
<td>3199 (2.0)</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>31–60 d</td>
<td>4922 (4.3)</td>
<td>5678 (3.6)</td>
<td>2.15 (2.03–2.28)</td>
<td>2.00 (1.88–2.13)</td>
</tr>
<tr>
<td>61–90 d</td>
<td>4859 (4.2)</td>
<td>5389 (3.4)</td>
<td>2.07 (1.95–2.19)</td>
<td>1.89 (1.78–2.01)</td>
</tr>
<tr>
<td>91 d – 1 y</td>
<td>17 146 (15.0)</td>
<td>22 966 (14.4)</td>
<td>2.50 (2.38–2.62)</td>
<td>2.14 (2.04–2.26)</td>
</tr>
<tr>
<td>2–5 y</td>
<td>33 463 (29.2)</td>
<td>48 899 (30.7)</td>
<td>2.73 (2.61–2.86)</td>
<td>2.15 (2.05–2.26)</td>
</tr>
<tr>
<td>6–17 y</td>
<td>48 171 (42.1)</td>
<td>73 588 (46.0)</td>
<td>2.85 (2.73–2.98)</td>
<td>2.23 (2.12–2.33)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>55 573 (48.5)</td>
<td>78 971 (49.4)</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Male</td>
<td>58 959 (51.5)</td>
<td>80 846 (50.6)</td>
<td>0.96 (0.95–0.98)</td>
<td>0.95 (0.94–0.97)</td>
</tr>
<tr>
<td>Ethnicityd</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-Hispanic</td>
<td>65 789 (57.4)</td>
<td>96 965 (60.7)</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Hispanic or Latinx</td>
<td>68 056 (5.8)</td>
<td>21 554 (13.5)</td>
<td>2.21 (2.15–2.28)</td>
<td>1.35 (1.30–1.40)</td>
</tr>
<tr>
<td>Unknown</td>
<td>42 137 (36.8)</td>
<td>41 300 (25.8)</td>
<td>0.67 (0.65–0.68)</td>
<td>1.82 (1.76–1.88)</td>
</tr>
<tr>
<td>Racec</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>32 718 (28.6)</td>
<td>58 623 (36.7)</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Asian American</td>
<td>25 500 (22.3)</td>
<td>26 862 (16.8)</td>
<td>0.59 (0.58–0.60)</td>
<td>0.59 (0.58–0.60)</td>
</tr>
<tr>
<td>Black</td>
<td>604 (0.5)</td>
<td>7642 (4.8)</td>
<td>7.06 (6.50–7.68)</td>
<td>3.80 (3.49–4.15)</td>
</tr>
<tr>
<td>Pacific Islander</td>
<td>783 (0.7)</td>
<td>841 (0.5)</td>
<td>0.60 (0.54–0.66)</td>
<td>0.50 (0.45–0.55)</td>
</tr>
<tr>
<td>Other</td>
<td>12 823 (11.2)</td>
<td>33 319 (20.8)</td>
<td>1.45 (1.42–1.49)</td>
<td>0.86 (0.84–0.89)</td>
</tr>
<tr>
<td>Unknown</td>
<td>42 104 (36.8)</td>
<td>32 532 (20.4)</td>
<td>0.43 (0.42–0.44)</td>
<td>0.23 (0.22–0.24)</td>
</tr>
<tr>
<td>Primary insuredf</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Private</td>
<td>110 915 (96.8)</td>
<td>117 788 (73.7)</td>
<td>Reference</td>
<td>Reference</td>
</tr>
<tr>
<td>Government</td>
<td>2756 (2.4)</td>
<td>40 955 (25.6)</td>
<td>13.99 (13.45–14.56)</td>
<td>12.76 (12.26–13.29)</td>
</tr>
<tr>
<td>Undocumented</td>
<td>881 (0.8)</td>
<td>1076 (0.7)</td>
<td>1.18 (1.08–1.29)</td>
<td>1.27 (1.15–1.38)</td>
</tr>
</tbody>
</table>

a Column percentages may not add up to 100% because of rounding.
b Multivariable regression model includes 274 349 of 274 551 (99.99%) visits because of missing data on sex. Binary sex data were missing for 2 well-child visits on the same patient who identifies as “other.”
c Reference group for the regression model was clinics that occasionally measure temperature.
d Race and ethnicity are self-reported fields. “Unknown” is the default option and includes patients who decline to answer the question. Because of small count, American Indian race was collapsed with patients who do not self-identify with any of the other listed races, classified as “other.”
f “Private” includes private insurance plans. “Government” includes Managed Medicare and Medi-Cal/Medicaid. “Undocumented” includes self-pay or missing insurance data.
all visit types (preventive and urgent care) and others routinely measure temperature on the basis of patient age, although no clear explanations for why some clinics chose to routinely measure temperature at all visit types or how age thresholds were chosen were provided. Detailed survey results are described in Supplemental Information.

Interventions by the Practice of Temperature Measurement

In unadjusted analysis, antibiotic prescriptions were prescribed more frequently at routine measurement than occasional measurement clinics (1.7% vs 1.4%; P < .001), but ≥1 diagnostic tests were obtained marginally less commonly (1.3% vs 1.4%; P < .01). After adjustment and clustering, the odds of prescribing antibiotics at routine measurement clinics remained higher than at occasional measurement clinics (adjusted odds ratio [aOR]: 1.21; 95% CI 1.13–1.29), and the odds of obtaining diagnostic testing remained lower (aOR: 0.76; 95% CI 0.71–0.82).

Interventions by Fever Status Among Well-Child Visits in Which Temperature Was Measured

At routine measurement clinics, 270 of 155,527 (0.2%) well-child visits had documented fever (≥100.4°F; 38.0°C). Of these 270 patients, 167 (61.9%) were classified as unlikely incidental fever, 56 (20.7%) were classified as possible incidental fever, 19 (7.0%) were classified as probable (noticed) incidental fever, and 28 (10.4%) were classified as probable (unnoticed) incidental fever. Table 2 shows rates of interventions by fever status. After adjustment and clustering, antibiotics and diagnostic testing had higher odds of being pursued at visits with a documented fever than visits with documented afebrile temperature (aOR: 10.2 [95% CI 7.4–14.1]; aOR: 17.6 [95% CI 12.8–24.3], respectively). Of visits with fever and associated interventions, 3 were for infants aged 0–90 days old. (The details of each case are described in Supplemental Information).

In visits in which fever was classified as probable (noticed or unnoticed) incidental fever, vaccines were deferred at 12 of 24 (50%) visits but were given by the next well-child visit in 9 of these 12 patients (75%) (Table 3). A total of 6 of 12 (50%) of vaccine deferrals were due to “parental preference,” 3 of 12 (25%) were due to “physician choice,” 2 of 12 (16.7%) had unclear progress note documentation (thus, the reason for vaccine deferral was “unable to be determined”), and 1 of 12 (8.3%) had a reason for deferral unrelated to the concurrent fever and illness (“other”). Examples of reasons for deferral are listed in Supplemental Table 6.

DISCUSSION

Within a large regional network of pediatric primary care clinics, we found that temperature was measured at slightly more than one-half of well-child visits, a proportion that aligns with our previous analysis using national data. In this current study, we provide more granular insight into the drivers of this practice and found that two-thirds of clinics measured temperature at nearly all visits and one-third at few. Routine temperature measurement may contribute to inappropriate antibiotic prescription, in part due to incidental fever detection. Although the overall rate of incidental fever detection is low, it may trigger overuse of health care resources and unnecessary vaccine deferral.

Why clinics appear to use an “all or none” approach to temperature measurement is unclear. We noted that patients with government insurance were more likely to be seen at routine measurement clinics, which aligns with our previous findings using national data. In

<table>
<thead>
<tr>
<th>TABLE 2 Rates of Interventions at Well-Child Visits in Which Temperature Was Measured at Routine Measurement Clinics, by Incidental Fever Category</th>
<th>Afebrile (≤100.4°F)</th>
<th>Any Fever (≥100.4°F)</th>
<th>Probable or Possible Incidental Fever</th>
<th>Probable (Noticed or Unnoticed) Incidental Fever</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. well-child visits</td>
<td>155,257</td>
<td>270</td>
<td>103</td>
<td>47</td>
</tr>
<tr>
<td>Interventions, n (%)</td>
<td>2654 (1.7)</td>
<td>45 (16.7)*</td>
<td>8 (7.8)*</td>
<td>4 (7.4)*</td>
</tr>
<tr>
<td>Antibiotic(s)*</td>
<td>1912 (1.2)</td>
<td>48 (17.9)*</td>
<td>15 (14.6)*</td>
<td>8 (14.8)*</td>
</tr>
<tr>
<td>≥1 diagnostics</td>
<td>3 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Blood culture</td>
<td>76 (0.0)</td>
<td>1 (10.4)</td>
<td>1 (1.0)***</td>
<td>1 (1.9)**</td>
</tr>
<tr>
<td>CRP</td>
<td>1547 (1.0)</td>
<td>3 (1.1)</td>
<td>1 (1.0)</td>
<td>2 (3.7)</td>
</tr>
<tr>
<td>CBC</td>
<td>47 (0.0)</td>
<td>19 (7.0)*</td>
<td>1 (1.0)*</td>
<td>0 (0.0)</td>
</tr>
<tr>
<td>Rapid influenza</td>
<td>250 (0.2)</td>
<td>29 (10.7)*</td>
<td>11 (10.7)*</td>
<td>5 (9.5)*</td>
</tr>
<tr>
<td>Rapid strep A</td>
<td>82 (0.1)</td>
<td>3 (1.1)*</td>
<td>5 (2.9)*</td>
<td>4 (7.4)*</td>
</tr>
</tbody>
</table>

* Antibiotic classes prescribed: Penicillins, sulfonamides, cephalosporins (1st and 3rd generation only), tetracyclines, macrolides, lincosamides, anti-Mycobacterium, nitrofurantoin, and metronidazole. Italicized antibiotics were also prescribed in patients with fever.

* P < .001 when comparing interventions at afebrile visits with that at the respective febrile visit; ** P < .01 when comparing interventions at afebrile visits with that at the respective febrile visit; *** P < .05 when comparing interventions at afebrile visits with that at the respective febrile visit.
some states, Medicaid requires temperature measurement at well-child visits. Although we are not aware of such a requirement in California (J. Elliot, Staff Services Manager of the Policy Development and Analytics Team and Benefits Division at the Department of Health Services, personal communication, November 19, 2020), Medicaid requirements in other states may have influenced decisions over temperature measurement. Additionally, our post hoc survey results noted that some clinics routinely measure temperature at all visit types. Routine measurement may be perceived to improve clinic efficiency by maintaining similar intake protocols across all visits.

We noted that routine measurement clinics prescribed antibiotics more frequently than occasional measurement clinics. Although causality for the higher rates of antibiotic prescription is challenging to prove, it is possible that the detection of fevers (or even borderline temperatures that did not meet our definition of fever) that would not otherwise have been noted influences decision-making around antibiotic prescriptions. However, we also noted that, after adjustment for possible confounders and clustering by clinic and patient, diagnostic testing was slightly less common at routine temperature measurement clinics. Although it is possible that providers are opting for antibiotic prescriptions in lieu of diagnostic testing, future research should be done to confirm these findings.

Incidentally detected fever may prompt inappropriate antibiotic prescription in the setting of viral symptoms or misdiagnosed bacterial infections. A cross-sectional study on febrile children seen at 2 ambulatory clinics determined that 64% of febrile patients were managed with oral antibiotics despite frequent diagnoses of viral infections, such as upper respiratory tract infections and gastroenteritis. Another study showed that pediatricians have low rates of compliance with the Centers for Disease Control and Prevention’s diagnostic criteria for acute otitis media (AOM) and that 99% of diagnosed AOM were treated with antibiotics, suggesting that overdiagnosis or misdiagnosis of AOM is contributing to excess antibiotic prescriptions. In addition, fever may prompt antibiotic treatment of infections that are often self-resolving. In a study including in-person and telephone pediatric ambulatory visits, the most common diagnoses for visits associated with fever (5%) were upper respiratory infections (URIs), AOM, and tonsillitis, of which the latter 2 infections often trigger antibiotic prescriptions, despite often improving without treatment. Although incidental fever detection through routine temperature measurement in well-appearing infants on rates of infectious diagnostic testing, antibiotic prescription, and hospital admission as well as diagnostic outcomes.

Given the high number of well-child visits that occur in the United States, even a small impact of temperature measurement on subsequent interventions could have a considerable effect at the population level. For example, if the association between routine temperature measurement and antibiotic prescription is in fact causal, the absolute risk difference in antibiotic prescriptions of 0.3% signifies that 3 additional antibiotic prescriptions are triggered by every 1000 visits in which temperatures are routinely measured. Based on an estimate of 52 million annual well-child visits from our previous US study, routine temperature measurement practices at well-child visits could translate to >150 000 additional antibiotic prescriptions per year.

We also found that vaccines were deferred at more than one-half of

### TABLE 3 Rates of Vaccine Deferral at Febrile Visits, by Incidental Fever Category

<table>
<thead>
<tr>
<th>Vaccine deferral rate, n (%)</th>
<th>Any Fever (≥100.4°F)</th>
<th>Possible or Probable Incidental Fever</th>
<th>Probable (Noticed or Unnoticed) Incidental Fever</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vaccine deferral rate, n (%)</td>
<td>138 of 163 (84.7)</td>
<td>45 of 61 (73.8)</td>
<td>12 of 24 (50.0)</td>
</tr>
<tr>
<td>Vaccine catch-up by next well-child visit, n (%)</td>
<td>119 of 138 (86.2)</td>
<td>36 of 45 (80.0)</td>
<td>9 of 12 (75.0)</td>
</tr>
<tr>
<td>Vaccine deferral reason, n (%)</td>
<td>Parental preference: 8 of 138 (5.8)</td>
<td>5 of 45 (11.1)</td>
<td>6 of 12 (50.0)</td>
</tr>
<tr>
<td></td>
<td>Physician choice: 43 of 138 (31.2)</td>
<td>17 of 45 (37.8)</td>
<td>3 of 12 (25.0)</td>
</tr>
<tr>
<td></td>
<td>Unable to determine: 85 of 138 (61.6)</td>
<td>22 of 45 (48.9)</td>
<td>2 of 12 (16.7)</td>
</tr>
<tr>
<td></td>
<td>Other: 2 of 138 (1.4)</td>
<td>1 of 45 (2.2)</td>
<td>1 of 12 (8.3)</td>
</tr>
</tbody>
</table>

a Column percentages may not add up to 100% because of rounding.
well-child visits associated with incidental fever detection, with rates varying by the category of incidental fever. Previous literature suggests that underimmunization varies by age, community, and the type of vaccine, with up to 25% of children experiencing at least 1 missed vaccination opportunity by 2 years of age. In these studies, the most common non–well-child visit diagnoses found to be associated with missed vaccine opportunities were AOM, upper respiratory tract infection, gastroenteritis, resolving illness, eczema, and impetigo. Investigators for both studies also considered fever (temperature: ≥100.4°F) to be a valid contraindication to vaccination. Although the incidence of incidental fever was low in our sample, the overall population impact on vaccine deferral may be clinically significant, given the high number of well-child visits annually in the United States. Furthermore, the fact that vaccine deferral was common in the context of incidental fever has significant implications for “catch-up” vaccination strategies, such as vaccination at urgent care visits. The Centers for Disease Control and Prevention Advisory Committee on Immunization Practices states that mild illness, including “low-grade fever, an upper respiratory infection (URI), a cold, otitis media, or mild diarrhea,” is an “invalid contraindication to vaccination.” Future educational and quality improvement efforts emphasizing the Advisory Committee on Immunization Practices’ recommendations may help curtail vaccine deferral.

Our study has limitations. First, acute complaints may have prompted temperature measurement. This was not evident in limited chart review and is unlikely to explain the wide variation in temperature measurement across clinics (>90% versus <20% of the time). Second, our categorization of incidental fever was based on progress note review and relied on accurate provider documentation of patients’ infectious symptoms. Furthermore, we only performed chart review on visits associated with fever. Some patients may have had elevated temperatures that did not meet the definition of fever but still triggered interventions because of concern for infection. Third, rates of fever, antibiotic prescriptions, and diagnostic testing were determined by temperature value documentation and relevant medication and procedure codes, respectively. We did not assess previous antipyretic use, the reasons for pursuing interventions, or patient compliance with prescribed antibiotics or diagnostic testing. Finally, in this study, we only include a single network of primary care clinics and may limit generalizability to other northern California Bay Area or US clinic practices.

CONCLUSIONS
Despite the lack of supportive recommendations, routine temperature measurement occurred at half of well-child visits in this study and seems to be a clinic-driven practice. The harm-benefit profile of the practice warrants consideration, especially given the rise in measurement as a screening tool during the coronavirus disease 2019 pandemic.

ABBREVIATIONS
ACIP: Advisory Committee on Immunization Practices
AOM: acute otitis media
aOR: adjusted odds ratio
CBC: complete blood cell count
CI: confidence interval
CRP: C-reactive protein
EMR: electronic medical record
ICD: International Classification of Diseases
OR: odds ratio
SMD: standardized mean difference
URI: upper respiratory infection

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