Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-19. The COVID-19 resource centre is hosted on Elsevier Connect, the company's public news and information website.

JAMDA 21 (2020) 895–899

JAMDA

journal homepage: www.jamda.com

Original Study

Temperature in Nursing Home Residents Systematically Tested for SARS-CoV-2

James L. Rudolph MD [a,b,c,*], Christopher W. Halladay ScM [a], Malisa Barber BS [a], Kevin W. McConeghy PharmD [a], Vince Mor PhD [a,b], Aman Nanda MD [c], Stefan Gravenstein MD [a,b,c]

[a] Providence Veterans Administration Medical Center, Providence, RI
[b] Brown University School of Public Health, Providence, RI
[c] Warren Alpert Medical School of Brown University, Providence, RI

Keywords:
Infection
nursing home
temperature

A B S T R A C T

Objectives: Many nursing home residents infected with SARS-CoV-2 fail to be identified with standard screening for the associated COVID-19 syndrome. Current nursing home COVID-19 screening guidance includes assessment for fever, defined as a temperature of at least 38.0°C. The objective of this study was to describe the temperature changes before and after universal testing for SARS-CoV-2 in nursing home residents.

Design: Cohort study.

Setting and Participants: The Veterans Administration (VA) operates 134 Community Living Centers (CLC), similar to nursing homes, that house residents who cannot live independently. VA guidance to CLCs directed daily clinical screening for COVID-19 that included temperature assessment.

Measures: All CLC residents (n = 7325) underwent SARS-CoV-2 testing. We report the temperature in the window of 14 days before and after universal SARS-CoV-2 testing among CLC residents. Baseline temperature was calculated for 5 days before the study window.

Results: SARS-CoV-2 was identified in 443 (6.0%) residents. The average maximum temperature in SARS-CoV-2–positive residents was 37.66 (0.69) compared with 37.11 (0.36) (P = .001) in SARS-CoV-2–negative residents. Temperatures in those with SARS-CoV-2 began rising 7 days before testing and remained elevated during the 14-day follow-up. Among SARS-CoV-2–positive residents, only 26.6% (n = 118) met the fever threshold of 38.0°C during the survey period. Most residents (62.5%, n = 277) with confirmed SARS-CoV-2 did experience 2 or more 0.5°C elevations above their baseline values. One cohort of SARS-CoV-2 residents' (20.3%, n = 90) temperatures never deviated >0.5°C from baseline.

Conclusions and Implications: A single screening for temperature is unlikely to detect nursing home residents with SARS-CoV-2. Repeated temperature measurement with a patient-derived baseline can increase sensitivity. The current fever threshold as a screening criteria for SARS-CoV-2 infection should be reconsidered.

Published by Elsevier Inc. on behalf of AMDA – The Society for Post-Acute and Long-Term Care Medicine.

Older people with chronic illness are at greatest risk for severe COVID-19 outcomes. In early March 2020, 34 (33.7%) of 101 SARS-CoV-2–infected residents died in a 130-bed Washington State King County nursing home facility; overall mortality was 18%. A total of 50 of 170 health care personnel were infected, along with 16 visitors.[1] These findings led to aggressive monitoring to detect disease, and to efforts to reduce transmission by keeping visitors and symptomatic staff out of the building, while isolating residents in whom COVID-19 was suspected or confirmed. However, of 76 residents with SARS-CoV-2 laboratory-confirmed infection, 57% were asymptomatic,[2] suggesting that symptomatic monitoring will fail to provide timely disease detection and undermine effective outbreak control.

Because threshold symptoms and signs, such as a temperature of at least 38.0°C, have been used to determine who is tested, their

The authors declare no conflicts of interest.

The study was funded by VA Health Services Research and Development and the National Institute of Aging 3P01AG027296-11S2 and approved by the Providence VAMC Institutional Review Board.

* Address correspondence to James L. Rudolph, MD, Providence VA Medical Center, SM 830 Chalkstone Avenue, Providence, RI 02908.
E-mail address: James.Rudolph@va.gov (J.L. Rudolph).

https://doi.org/10.1016/j.jamda.2020.06.009
1525-8610/Published by Elsevier Inc. on behalf of AMDA – The Society for Post-Acute and Long-Term Care Medicine.

frequency may underestimate SARS-CoV-2 population prevalence. Standard screening processes now routinely screen for COVID-19 by assessing for temperature >38.0°C. From the King County experience,[1,3] "fever" is limited as a screening criterion for COVID-19 in nursing facilities.[4] Although the utility of fever as an indicator has been debated for older adults,[5,6] studies have reported that nursing home residents with pneumonia often present without fever[7,8] and have a lower basal temperature than community-dwelling older adults.[9] The "older and colder" adage for nursing home residents may have statistical validity but poses challenges in guiding nursing facilities about fever during a pandemic.

Although COVID and pneumonia can elevate temperature from within an individual's usual range, an absolute, universal cutoff for fever may miss potentially important temperature perturbations. With infection control practices presently dependent on a threshold temperature criterion to determine fever, we need to better understand the value and limitations such a threshold adds to identifying people infected with SARS-CoV-2 or appropriate actions for additional screening, especially in a nursing home context. We hypothesized that most residents of Veterans Administration Community Life Centers (CLCs) infected with SARS-CoV-2 do have temperature elevations well ahead of a confirmatory test, but also that peak temperatures will not typically meet the current screening criterion threshold of 38°C that follows the Centers for Disease Control and Prevention's (CDC) guidance.[10,11]

Methods

This study was approved by the Providence Veterans Administration Medical Center's Institutional Review Board.

Setting and Context

The VA Healthcare System (VHA) owns and operates 134 CLCs, providing a nursing home environment that serves 8800 veterans on a daily basis. The recognition of COVID-19's emerging risk specific to veterans in CLCs drove a decision by the VHA to try to systematically identify, isolate, and care for CLC veterans with asymptomatic SARS-CoV-2 infection or COVID-19. On March 10, 2020, the VHA issued isolation and temperature guidance to CLCs, including daily monitoring of temperature. On April 14, 2020, VHA guidance required 1-time universal SARS-CoV-2 testing of all CLC residents and staff. The purpose of this analysis was to compare temperature trends and identify maximum temperatures in nursing home residents 14 days before and after systematic testing for SARS-CoV-2 throughout VHA CLCs.

Cohort

Using VHA electronic records, we identified veterans residing in CLCs during the period of March 1, 2020 until May 4, 2020. Veterans who were not tested for COVID-19 were excluded, as were those tested before admission to the CLC. In addition, we excluded those who were symptomatically tested because of symptoms before universal testing. Demographic descriptors were collected from the electronic medical records.

Temperature Measurement

Each CLC uses standard equipment to measure temperature, and enters the reading into the electronic medical record. In most CLCs, temperature is uploaded directly to the electronic medical record from the vital signs machine. Based on CDC guidance, the fever threshold was established at 38.0° C.[10,11] For this analysis, we selected the first temperature after 4 AM for analysis. We assessed temperatures in the 2 weeks before and after SARS-CoV-2 testing. To establish a baseline temperature for each resident, we calculated the mean of 5 temperatures before our window of interest.

COVID-19 Measurement

We identified SARS-CoV-2 polymerase chain reaction (PCR) testing results from the VA's electronic medical records. The VHA developed a harmonized definition of SARS-CoV-2 test results, requiring a PCR test from a certified laboratory.

Statistics

Those with reverse-transcriptase PCR–confirmed SARS-CoV-2 infection and those without were compared graphically and statistically. Continuous variables were confirmed with a Student's *t*-test; categorical variables were compared with χ^2. Missing temperature data are described in online Supplementary Material 1. Analyses were performed in R 3.6.1; plots were created with the ggplot2 package.

Role of the Funder

The funder had no role in the design, data collection, analysis, interpretation, or writing of this study.

Results

The cohort consisted of veterans (n = 7325) residing in CLCs. A total of 453 (6.0%) veterans tested positive for SARS-CoV-2. Those in whom SARS-CoV-2 was confirmed were older (76.2 vs. 74.2 years, $P < .001$) than those with negative results (Table 1). Racial differences were small and without statistically significant differences. SARS-CoV-2–positive residents had a higher maximum temperature (37.7 vs. 37.1°C, $P < .001$). In both cohorts, the baseline temperature was 36.6°C (SD ± 0.2) and a temperature deviation of 2 SD is approximately 0.5°C.

Figure 1 illustrates the first daily temperatures of those with and without SARS-CoV-2 infection. Residents with confirmed SARS-CoV-2 infection had statistically if not clinically significant temperature elevations beginning 7 days before COVID testing. The highest temperature in the SARS-CoV-2+ group peaked on the day of testing

Table 1
Baseline Characteristics of Population

	Mean (SD), n (%)		*P* value
	SARS-CoV-2+	SARS-CoV-2−	
N	443	6882	
Age, y	76.3 (10.8)	74.2 (10.9)	<.001
Sex			
Male	432 (97.5%)	6605 (96.0%)	.085
Female	11 (2.5%)	277 (4.0%)	
Race			.084
White	286 (64.56%)	4724 (68.64%)	
Black	123 (27.77%)	1593 (23.15%)	
Other races	34 (7.67%)	565 (8.21%)	
Comorbidities			
Obesity	101 (22.8%)	1913 (27.8%)	.026
Hypertension	309 (69.8%)	4805 (69.8%)	1.00
Heart failure	102 (23.0%)	1865 (27.1%)	.069
Lung disease	142 (32.0%)	2525 (36.7%)	.056
Diabetes	165 (37.2%)	2780 (40.4%)	.208
Dementia	301 (68.0%)	4298 (62.4%)	.023
Temperature			
Maximum,* °C	37.66 (0.69)	37.11 (0.36)	<.001
Any fever*	118 (26.64%)	201 (2.92%)	<.001
Baseline temperature, °C			
Average†	36.59 (0.21)	36.56 (0.24)	.001

*During 29-day analytic window surrounding SARS-CoV-2 testing.
†Five-day window before the analytic window.

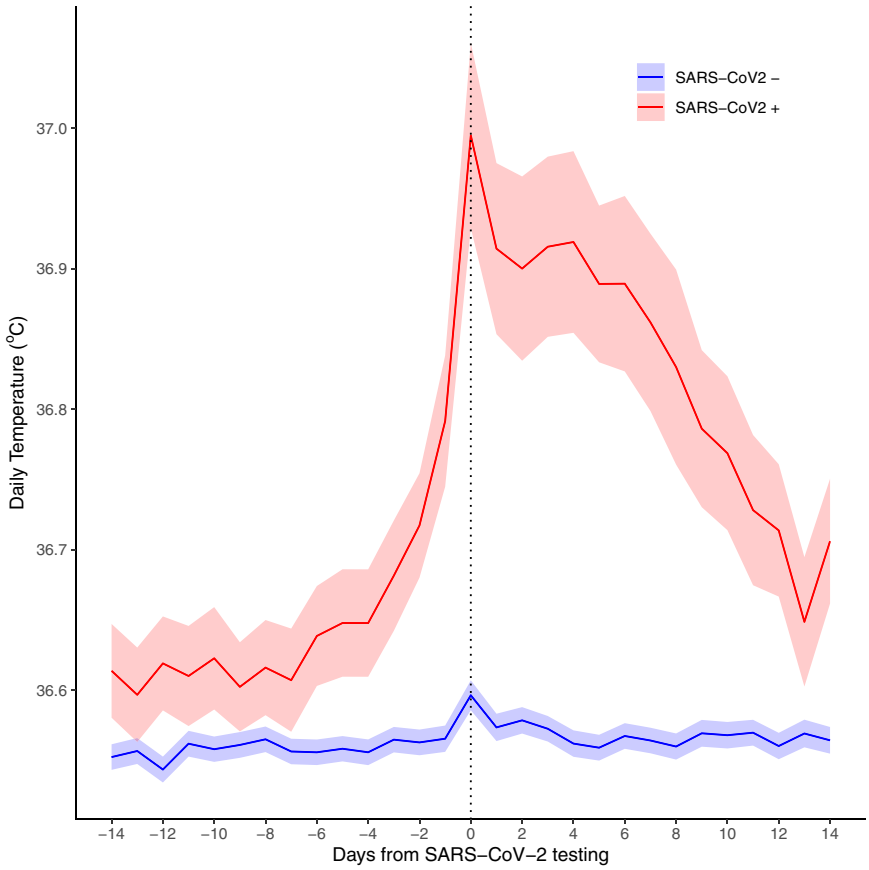

Fig. 1. Temperature in nursing home residents with and without SARS-CoV-2. The graph depicts daily temperature before (negative days) and after (positive days) the testing for SARS-CoV-2 (T0). The shaded area represents the 95% confidence intervals.

(37.0 ± 0.6°C) at which time 28 (6.3%) of these residents met the CDC-guided 38.0°C fever criterion. During the 14 days of follow-up, the average temperature in those with SARS-CoV-2+ test did not fall within 0.1°C of the group without SARS-CoV-2 infections.

Figure 2 centers the maximum temperature (Tmax) during the 2 weeks preceding and following the SARS-CoV-2 testing. Among those with confirmed SARS-CoV-2, those (n = 118, 26.6%) who mounted a Tmax ≥38.0°C had higher temperatures during the entire 4-week window. Those with SARS-CoV-2 in the lowest Tmax quartile had the least temperature variation. The CDC fever threshold of 38°C was not met by 73.4% of residents during the study window. Supplemental Table 1 lists single timepoint temperature screening thresholds.

Measurement of temperature deviation from baseline has been proposed as a mechanism to detect underlying infectious disease in nursing home residents. Most residents (79.7%, n = 353) with confirmed SARS-CoV-2 did experience a 0.5°C elevation of their baseline values, and this elevation was noted at least twice in 62.5% (n = 277) (Table 2). Figure 3 examines potential temperature change from baseline values (0°C to 2.5°C) occurring more than once (Figure 3A) and more than twice (Figure 3B). Using a threshold increase from baseline occurring in multiple readings offers a favorable balance of sensitivity and specificity relative to a single reading.

Discussion

We describe peak and daily morning temperature variation 2 weeks before and after COVID-19 testing among VA CLC residents and the Tmax occurring during that interval. The morning temperatures in CLC residents with SARS-CoV-2 typically began rising a week or more before reaching Tmax. Most residents (74%) did not reach a peak temperature over 38.0°C. The temperature for those with SARS-CoV-2 whose Tmax was at least 0.5°C higher from baseline generally remained elevated for the 14 days of follow-up.

Current guidance from the CDC focuses on temperature monitoring for COVID-19 surveillance.[10,11] Although fever adds specificity for COVID-19 screening, fever of 38.0°C has not been reliably present, even for those reporting to the hospital; only 42% have met the CDC fever criterion.[1] A fever threshold definition of 38.0°C can serve as an excellent proxy for underlying COVID-19 population prevalence, but such a threshold lacks sensitivity for surveillance purposes when applied to a nursing home population. Such a high threshold can delay early recognition of the need for and implementation of systematic testing and additional life-saving infection control measures for frail, older nursing residents. Most (62.5%, n = 277) CLC residents with SARS-CoV-2 have at least 2 deviations from baseline of 0.5°C, which is more sensitive and specific than an absolute threshold of 38°.0C. As a result, the current fever threshold as a screening criterion for SARS-CoV-2 infection should be reconsidered.

This is the latest in a string of literature that describes substantial variability in baseline vital signs among older people.[7–9] With the use of electronic health records (EHRs) that store vital signs, including temperature, we can establish a personalized baseline temperature range for the older nursing facility resident,[5,6] thus allowing the record EHR system to alert staff when a resident's temperature exceeds this range. It is time to assess if an EHR alert of out-of-range

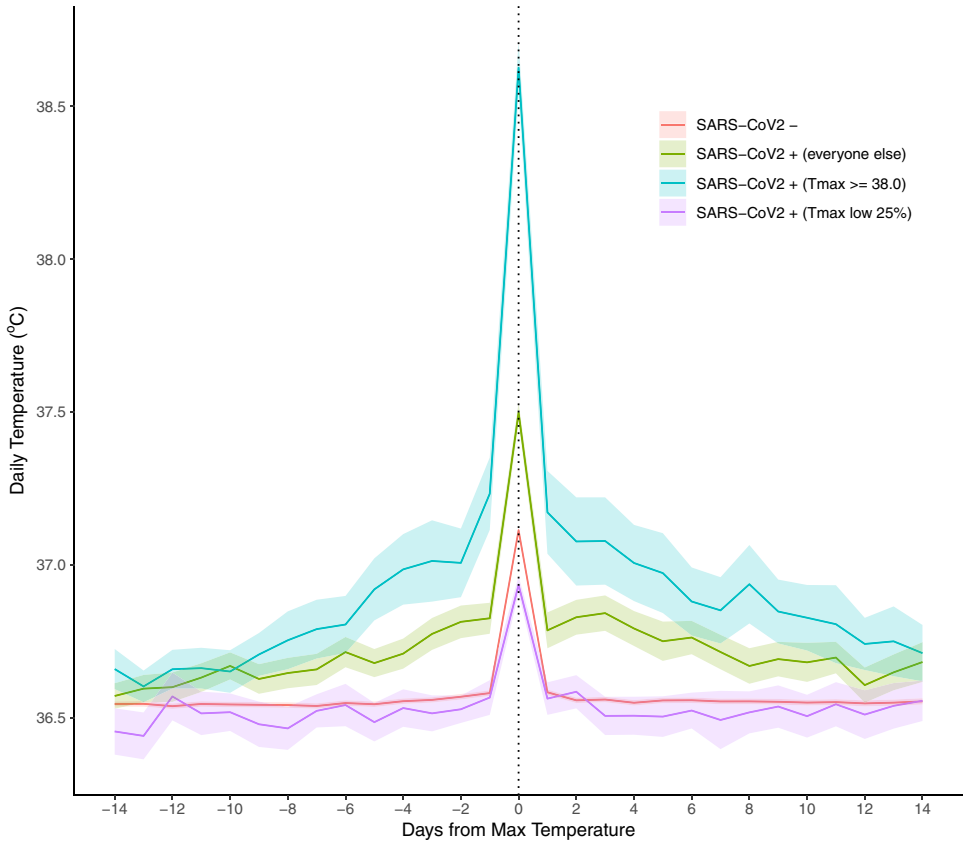

Fig. 2. Temperature trends according to maximum temperature. This compares daily temperatures relative to the maximum temperature. T0 is defined as the day of maximum temperature. SARS-CoV-2 groups are defined as those who are able to mount a maximum temperature of ≥38.0°C, the lowest quartile, and the remainder. The shaded area represents the 95% confidence intervals.

temperatures can improve disease surveillance and result in earlier interventions in general, if not specifically for COVID-19.

The strengths of this analysis include the robust nursing home sample, the near universal monitoring of COVID-19, and the daily monitoring of temperature. These data collections allow for the construction of a more comprehensive picture of temperature and vital signs and can also inform decisions for SARS-CoV-2 testing and follow-up. We note 2 important limitations. First, we have not distinguished sensitivity of temperature thresholds for SARS-CoV-2 detection when separated between individuals who have met other symptom screening criteria from those who do not. However, the systematic approach by the VHA to perform national testing and the exclusion of individuals with known COVID-19 suggest that the vast majority of these individuals were asymptomatic at the time of testing. Second, the findings may not be generalizable to an older population as a whole because our sample is limited to one that is predominantly male with extensive comorbidities. The universal screening provided an important measurement structure, but limits our knowledge of which residents might have been screened otherwise.

Conclusions and Implications

Most older nursing home residents do have temperature elevations when infected with SARS-CoV-2, but this elevation infrequently meets a fever threshold 38.0°C. Lower temperature excursions, such as 0.5°C, can improve sensitivity and recurrent excursions specificity for SARS-CoV-2 infection. Consideration of triggering COVID-19 screening based on an excursion threshold from a personalized temperature range may lead to earlier recognition of COVID-19 activity in a long-term care setting.

Table 2
Repeated Temperature Elevation Among Maximum Temperature Quartiles of SARS-CoV-2+

	N	Temperature Readings Above Criteria			
		≥1 n (%)	≥2 n (%)	≥3 n (%)	≥4 n (%)
Temperature change of 0.5°C from baseline					
SARS-CoV-2−	6882	3417 (49.6)	2052 (29.8)	1326 (19.3)	905 (13.2)
SARS-CoV-2+ Tmax quartile					
Lowest	107	33 (30.8)	21 (19.6)	15 (14.0)	6 (5.6)
2nd	115	104 (90.4)	67 (58.3)	48 (41.7)	30 (26.1)
3rd	113	111 (98.2)	92 (81.4)	75 (66.4)	58 (51.3)
Highest	108	105 (97.2)	97 (89.8)	83 (76.8)	71 (65.7)

Tmax, maximum temperature.

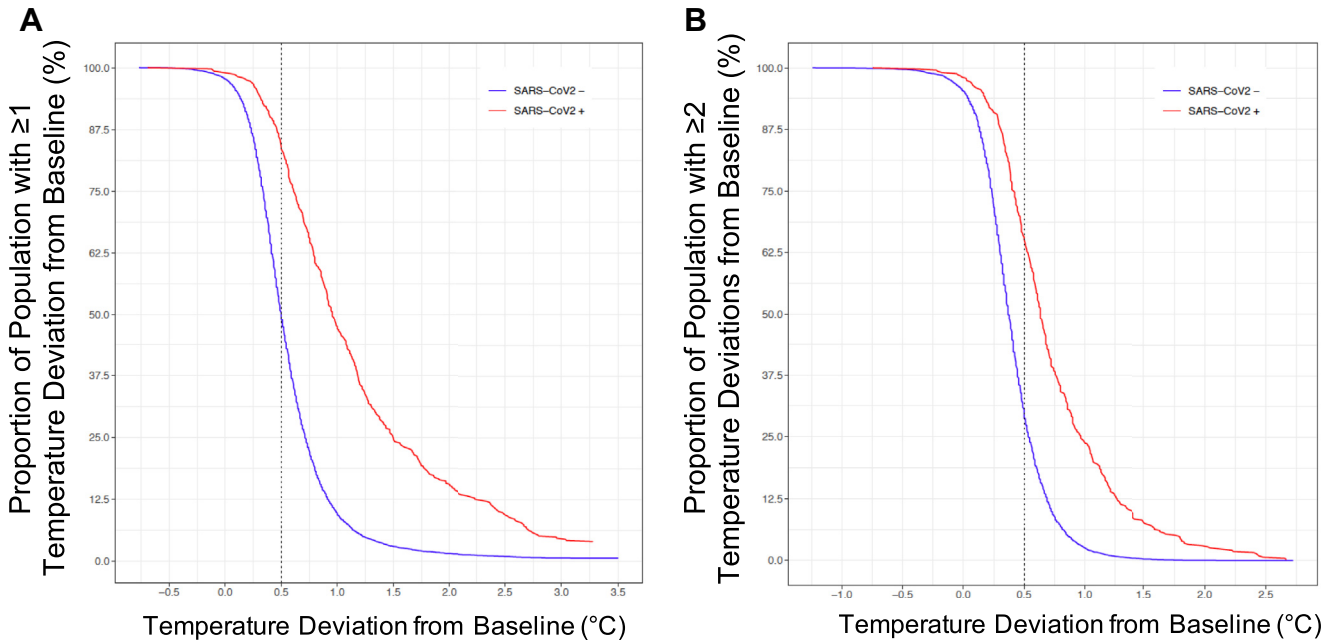

Fig. 3. Change from baseline thresholds in SARS-CoV-2. (A) Percentage of the population that attains 1 or more change(s) from baseline. (B) Those with 2 or more changes from baseline. A reference line is drawn at 0.5°C change.

Acknowledgments

This work was funded by VA Health Services Research and Development (CIN 13-419 and C19 20-213) and the National Institute of Aging 3P01AG027296-11S2. All authors are VA employees. We are indebted to the VHA Offices of Geriatrics and Extended Care, Population Health, and Reporting, Analytics, Performance Improvement, and Deployment. The opinions expressed are those of the authors and do not reflect the official policies of the US government or the US Department of Veterans Affairs.

Contributions of Authors: JLR, SG: Literature search, study design, data analysis, interpretation, writing. CWH: Design, data collection, data analysis, data interpretation, writing. MB: Data collection, data analysis, writing. KM: Study design, data analysis, data interpretation, writing. AN: Data interpretation, writing. VM: Data analysis, data interpretation, writing.

References

1. McMichael TM, Currie DW, Clark S, et al. Epidemiology of Covid-19 in a long-term care facility in King County, Washington. N Engl J Med 2020;382:2005–2011.
2. Kimball A, Hatfield KM, Arons M, et al. Asymptomatic and presymptomatic SARS-CoV-2 infections in residents of a long-term care skilled nursing facility - King County, Washington, March 2020. MMWR Morb Mortal Wkly Rep 2020; 69:377–381.
3. Arons MM, Hatfield KM, Reddy SC, et al. Presymptomatic SARS-CoV-2 infections and transmission in a skilled nursing facility. N Engl J Med 2020;382: 2081–2090.
4. Gudbjartsson DF, Helgason A, Jonsson H, et al. Spread of SARS-CoV-2 in the Icelandic population. N Engl J Med 2020;382:2302–2315.
5. High KP, Bradley SF, Gravenstein S, et al. Clinical practice guideline for the evaluation of fever and infection in older adult residents of long-term care facilities: 2008 update by the Infectious Diseases Society of America. Clin Infect Dis 2009;48:149–171.
6. Chester JG, Rudolph JL. Vital signs in older patients: Age-related changes. J Am Med Directors Assoc 2011;12:337–343.
7. Rosenberg G. The significance of pneumonia in the elderly. Can Fam Physician 1987;33:1255–1258.
8. Sloane PD, Kistler C, Mitchell CM, et al. Role of body temperature in diagnosing bacterial infection in nursing home residents. J Am Geriatr Soc 2014;62: 135–140.
9. Castle SC, Norman DC, Yeh M, et al. Fever response in elderly nursing home residents: Are the older truly colder? J Am Geriatr Soc 1991;39:853–857.
10. Centers for Disease Control and Prevention. Evaluating and testing persons for Coronavirus Disease 2019 (COVID-19). Available at: https://www.cdc.gov/coronavirus/2019-ncov/hcp/clinical-criteria.html. Accessed May 11, 2020.
11. Department of Health and Human Services. Definition of ill person. Fed Regist 2017;82:6890–6972.

Supplemental Table 1
Temperature Cutoffs and SARS-CoV-2

	Mean (SD), n (%)	
	SARS-CoV-2+	SARS-CoV-2−
N	443 (100.00%)	6882 (100.00%)
Average baseline temperature	36.59 (0.21)	36.56 (0.24)
Minimum baseline temperature	36.31 (0.26)	36.25 (0.31)
Maximum baseline temperature	36.90 (0.31)	36.87 (0.29)
No change from Baseline	421 (95.03%)	6682 (97.09%)
Increase 0.1°C from baseline	419 (94.58%)	6511 (94.61%)
Increase 0.2°C from baseline	414 (93.45%)	6152 (89.39%)
Increase 0.3°C from baseline	400 (90.29%)	5438 (79.02%)
Increase 0.4°C from baseline	381 (86.00%)	4396 (63.88%)
Increase 0.5°C from baseline	353 (79.68%)	3417 (49.65%)
Increase 0.6°C from baseline	319 (72.01%)	2479 (36.02%)
Increase 0.7°C from baseline	288 (65.01%)	1761 (25.59%)
Increase 0.8°C from baseline	251 (56.66%)	1226 (17.81%)
Increase 0.9°C from baseline	222 (50.11%)	858 (12.47%)
Increase 1.0°C from baseline	192 (43.34%)	623 (9.05%)
Increase 1.1°C from baseline	172 (38.83%)	459 (6.67%)
Increase 1.2°C from baseline	141 (31.83%)	334 (4.85%)
Increase 1.3°C from baseline	122 (27.54%)	260 (3.78%)
Increase 1.4°C from baseline	107 (24.15%)	207 (3.01%)
Increase 1.5°C from baseline	92 (20.77%)	162 (2.35%)
Increase 1.6°C from baseline	85 (19.19%)	136 (1.98%)
Increase 1.7°C from baseline	77 (17.38%)	110 (1.60%)
Increase 1.8°C from baseline	64 (14.45%)	92 (1.34%)
Increase 1.9°C from baseline	56 (12.64%)	78 (1.13%)
Increase 2.0°C from baseline	51 (11.51%)	64 (0.93%)
Tmax ≥36.5°C	442 (99.77%)	6777 (98.47%)
Tmax ≥37.0°C	390 (88.04%)	4678 (67.97%)
Tmax ≥37.5°C	229 (51.69%)	742 (10.78%)
Tmax ≥38.0°C	118 (26.64%)	201 (2.92%)
Tmax ≥38.5°C	60 (13.54%)	83 (1.21%)

Tmax, maximum temperature.