

Defining Fever

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Although the term “fever” is used liberally in clinical publications, we provide evidence that it is rarely defined in terms of the minimum temperature used to qualify as a fever, the type of thermometer employed in measuring patients’ temperatures, or the site at which temperatures are taken. We maintain that in the absence of such information, the term “fever” is meaningless.

Keywords. COVID-19; fever; normal range; temperature; thermometer; Wunderlich.

“Measure what is measurable, and make measurable what is not so.”

— Attributed to Galileo Galilei

Physicians since antiquity have looked to fever as one of the cardinal manifestations of ill health and, for nearly 2 centuries, have had instruments with which to verify fever’s presence in the ill patient. Given the medical profession’s intense interest in fever since time immemorial, one would expect there to be a universally accepted definition of the entity. In physiological terms, fever has been defined as “a state of elevated core temperature, which is often, but not necessarily, part of the defensive response of multicellular organisms to invasion by live microorganisms or inanimate matter recognized as pathogenic or alien by the host” [1]. Unfortunately, this physiological definition has limited utility clinically, because of the lack of agreement as

to the meaning of “a state of elevated core temperature.” Despite millennia of attention devoted to patients’ temperatures, no universally accepted thermal definition of fever exists to this day.

The absence of such a universally accepted definition has been especially problematic during the current coronavirus disease 2019 (COVID-19) pandemic. In that “fever” is the single most frequently reported manifestation of the illness, examining persons for its presence has emerged as a critical element of screening programs for the infection. In one of the earliest published series of COVID-19 cases, Huang et al [2] detected fever in 40 of 41 (98%) cases, compared to cough in 31 (76%) and myalgia or fatigue in 18 (44%). Interestingly, although Huang et al [2] included definitions for acute respiratory distress syndrome, hypoxemia, acute kidney injury, secondary infection, and cardiac injury in their manuscript, they provided no information on how temperatures were measured or the minimum temperature used to define a fever.

While universally accepted normal ranges have been established for other vital signs, temperature is an exception. There is no agreement as to the upper limit of the normal temperature range in humans (ipso facto, the lower limit of the febrile range). Moreover, like the Huang et al report [2], publications involving “febrile” patients rarely include a definition of fever or the method employed in

measuring patients’ temperatures. The lack of such information is critical, given the fact that patients’ temperatures vary according to the location at which measurements are taken (eg, oral, tympanic, axillary, rectal, skin); the type of thermometer used (eg, contact, noncontact, handheld thermal scanner); the time of day; and patients’ age, sex, and race [3].

The pervasiveness of the failure to define fever in publications dealing with “febrile” patients is reflected in an investigation we recently undertook to determine the extent to which fever is defined in publications concerned with COVID-19 [4]. Of 53 publications identified which included the term “fever” as a manifestation of COVID-19, none (0/53) described the method used in measuring patients’ temperatures. Only 10 of 53 (19%) specified a minimum temperature used to define fever, which ranged from a low of 37.2°C (98.9°F) to a high of 38.1°C (100.6°F). These data have implications for the care not just of COVID-19 patients but patients in general.

Because fever has been reported to be one of the earliest signs of symptomatic COVID-19, its detection has been incorporated as a fundamental component into COVID-19 screening programs. In the absence of the specific criteria used to define a fever in such programs, the assumption is that any criteria used to define fever are as good as any other, ignoring the fact that how fever is defined is key to the success of such programs. Moreover,

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in patients in general, the presence of fever frequently determines when nurses or patients themselves are instructed to “call the doctor,” when a particular diagnostic evaluation is indicated, when to begin (or terminate) treatment, and so on. In the absence of a clear definition of what is meant by “a fever,” in terms of a specific minimum temperature, site at which the temperature is taken, and the type of thermometer used, fever’s capacity to direct these aspects of patient care is compromised.

To determine the extent to which fever is defined and the methods used to measure patients’ temperatures are described in clinical publications in general, we performed a similar investigation of non-COVID-19 publications with “fever” in the title and/or abstract appearing in 3 top-tier medical journals (*New England Journal of Medicine*, *JAMA*, and *The Lancet*) between 2010 and 2020. Of 255 non-COVID-19 publications identified, we excluded 175 that were case reports, cited “fever” only as an element of the name of a disease (eg, “yellow fever”) or were letters to the editor, leaving 70 publications for analysis ([Supplementary Appendix](#)). Of these, only 27.1% (19/70) gave the minimum temperature used to define a fever, with values ranging from 37.5°C (99.5°F) to 40°C (104°F). A mere 4.3% (3/70) described the location at which patients’ temperatures were measured. Thus, clinical publications in general, like COVID-19 publications in particular, rarely provide basic information concerning their definition of fever.

The failure to describe the anatomic site at which measurements are taken is especially problematic, given the variation in temperature existing at various sites throughout the human body. The extent of such variation is illustrated in a recent review by Geneva et al [5], which identified the following average temperatures for sites most often used in measuring patients’ temperatures: rectal, 37.04°C (98.7°F); tympanic, 36.64°C (98.0°F); urine, 36.61°C (97.9°F); oral, 36.57°C (97.80°F); and axillary, 35.97°C (96.7°F).

Temperature readings also vary according to the type of instrument used. Traditionally, contact thermometers that are placed on the forehead or in the mouth, ear, axilla, or rectum have been used to monitor patients’ temperatures. Noncontact thermometers, which have become the preferred instruments from an infection control standpoint when screening patients for COVID-19, allow temperatures to be taken with minimal (tympanic) or no (noncontact infrared thermal scanners) physical contact with the person being examined. There is no consensus as to the optimal cutoff temperature for determining the existence of a fever for any of these devices.

Carl Reinhold Wunderlich (1815–1910) is credited with proposing one of the earliest evidence-based definitions of fever based on the results of an analysis of a vast number of axillary temperatures taken from patients in his clinic in the first half of the 19th century [6]. As per his observations, he defined a slight fever as 38°C–38.4°C (100.4°F–101.1°F), a moderate fever as 38.5°C–39°C (101.3°F–102.2°F), and considerable fever as 39.5°C–40.5°C (103.1°F–104.9°F), with cutoffs lower in the morning than in the evening. Currently, according to *Harrison’s Principles of Internal Medicine* [7], fever is defined as a core temperature (rectal) of 37.5°C–38.3°C (99.5°F–100.9°F), a skin temperature (axillary) >37.2°C (>99°F), a morning oral temperature >37.2°C (>99°F), or late afternoon oral temperature >37.7°C (>99.9°F), with lower thresholds applicable to frail elderly persons. The Merck Manual defines fever as an oral temperature >37.8°C (>100.0°F) or a rectal temperature >38.2°C (>100.8°F) or a temperature higher than a person’s known normal daily value [8].

Given the many factors influencing the results of temperature measurements in humans, there can never be a single, universally accepted temperature cutoff defining a fever. This clinical reality, however, does not obviate the need for precision in reporting fever. To achieve the needed

precision and thereby improve scientific and clinical communication, when fever is reported in clinical investigations, the specific cutoff temperature used in determining the presence of fever (or simply presenting patients’ temperatures themselves), the anatomical site at which temperatures are taken, and the instrument used to measure temperatures should each be described. In the absence of such information, what is meant by the term “fever” is anyone’s guess. In scientific publications, measuring what is measurable is not enough. The results of measurements and the means by which they are obtained must be clearly delineated.

Supplementary Data

Supplementary materials are available at *Open Forum Infectious Diseases* online. Consisting of data provided by the authors to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the authors, so questions or comments should be addressed to the corresponding author.

Notes

Potential conflicts of interest. All authors: No reported conflicts of interest.

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