Temperature Measurement Timings Determine the Fever Detection Rate after Gastrointestinal Surgery: A Retrospective Cross-Sectional Study

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Abstract

Background: Postoperative fever can either be detected by medical staff intermittently or by sensors continuously. What is the fever detection rate under intermittent measurement?

Objective: To investigate the fever detection rate under intermittent measurement and to investigate the clinical relevance of the detected fever.

Methods: The clinical record of patients who underwent nonemergency gastrointestinal surgery between November 2020 and April 2021 were retrospectively reviewed. The temperature data of the patients that were collected by the sensor were retrieved. Fever was defined whenever temperature exceeded 38.0? in one day. To simulate the intermittent measurement in clinical work, body temperature on every hour were picked from the continuously collected temperature data set. Considering that temperature are measured several times per day, every possible measurement plan by intermittent measurement was composed by combining 1 to 24 time points from the 24 hours daily, and fever was diagnosed base on the temperature on the selected time points per day. Fever detection rates of every plans with varied measurement times were listed and ranked.

Results: Based on the temperature data that were continuously collected by the sensors, fever occurred in 60 (40.82%) of the included 147 patients within three days after surgery. The detection rate of the intermittent approaches was determined by the measurement timings and times. Of the measurement plans that take one to twenty-four measures daily, the fever detection rate were ranged from 3.3% to 85.0%. The highest detection rates and the corresponding timings of the measurement plans that take measures once, twice, three times, and four times daily were 38.33% (at 20:00), 56.67% (at 3:00, and 19:00/20:00), 65.00% (at 3:00, 20:00, and 22:00/23:00), and 70.00% (at 0:00, 3:00, 20:00, and 23:00), respectively. Although fever within three days after surgery was not correlated with an increased incidence of postoperative complications (18.3% vs. 11.9%, p=0.695), it was correlated with a longer hospital stay (median 7 (IQR 6, 9) vs. median 6 (IQR 5, 7), p<0.001).

Conclusions: Intermittent measurement may never achieve a comparable detection rate with the continuous measurement. However, the fever detection rate at intermittent measurement time points can be improved by adjusting the measurement times.

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Original Manuscript

Temperature Measurement Timings Determine the Fever Detection Rate after Gastrointestinal Surgery: A Retrospective Cross-Sectional Study

Abstract

Background:

Postoperative fever frequently indicates surgical related complications and is commonly utilized to evaluate the efficacy of interventions against surgical stress. The presence of circadian rhythms in body temperature, however, may compromise the accurate detection of fever.

Objective:

To investigate the detection rate of fever under intermittent measurement.

Methods:

We retrospectively reviewed the clinical record of patients who underwent non-emergency gastrointestinal surgery between November 2020 and April 2021. Patients' temperature data were continuously collected every four seconds by a wireless axillary thermometer, and fever was defined as a temperature exceeding 38.0℃ within a day. To simulate intermittent measurement in clinical practice, the body temperature at each hour was selected from the continuously collected temperature data set. Considering that temperatures are measured multiple times per day, all possible measurement plans using intermittent measurement were composed by combining 1 to 24 time points from the 24-hour daily cycle. Fever was clinically diagnosed based on the temperature at the selected time points per day. The fever detection rates for each plan with varying measurement times were listed and ranked.

Results:

Based on the temperature data continuously collected by the thermometer, fever occurred in 60 (40.82%) of the 147 included patients within three days after surgery. Of the measurement plans that included one to twenty-four measurements daily, the fever detection rates ranged from 3.3% to 85.0%. The highest detection rates and corresponding timings for measurement plans with one, two, three, and four measurements daily were 38.33% (at 20:00), 56.67% (at 3:00 and 19:00/20:00), 65.00% (at 3:00, 20:00, and 22:00/23:00), and 70.00% (at 0:00, 3:00, 20:00, and 23:00), respectively; and the lowest detection rates were 3.3%, 6.67%, 6.67%, and 8.33%, respectively. Although fever within three days after surgery was not correlated with an increased incidence of postoperative complications (18.3% vs. 11.9%, $p=0.695$), it was correlated with a longer hospital stay (median 7 [IQR 6, 9] vs. median 6 [IQR 5, 7], $p<0.001$).

Conclusions:

The fever detection rate of intermittent approach is determined by the timing and frequency of measurement. Measuring at randomly selected time points misses many fever events after gastrointestinal surgery. However, we can improve the fever detection rate by adjusting the measurement times and timings.

Keywords:

Fever; gastrointestinal surgery; temperature measurement

Introduction

Fever commonly ensues following a diverse array of surgical interventions, including gastrointestinal procedures. Postoperative fever frequently stems from surgical stress and complicating factors [1, 2]. In the context of gastrointestinal surgery, fever not only reflects elevated levels of surgical stress, but may also signal the potential for complications such as thrombosis, gastrointestinal leaks, intra-abdominal and pulmonary infections [3-7]. Additionally, fever manifestations are integral to the evaluation of targets and outcome measures for various Enhanced Recovery After Surgery (ERAS) interventions [8-14]. Therefore, precise fever detection is imperative for ensuring clinical safety and for the accurate appraisal of treatment efficacy. Timely and accurate detection of fever promotes the early identification of patients at heightened risk for complications and supports the precise assessment of the efficacy of perioperative stress mitigation strategies.

To detect postoperative fever, patient temperatures are routinely measured at intervals of several hours against a predetermined threshold. Majority of healthcare facilities use a body temperature over 38°C as the criterion for fever diagnosis [15]. This threshold is also commonly used in many clinical researches [5, 16, 17]. Nevertheless, there is often a failure to account for the timing of temperature measurements, which is pivotal since body temperature naturally oscillates, reaching a nadir at 6 a.m. and peaking between 4 p.m. and 6 p.m. [18]. As such, disparate measurement timings can result in substantial variance in the detected rates of fever within study cohorts. The question arises as to the optimal timing for temperature checks to identify fever. To date, neither a consensus nor guidelines exist to address this issue. Furthermore, the timing of temperature measurement is rarely specified in the literature on postoperative fever, with common practices including twice daily [17], during morning rounds [16], every eight hours [19, 20], or no report at all in certain studies [5, 9, 17, 21-25]. This inconsistency in monitoring may overlook many febrile episodes, impeding the ability to evaluate the relationship between fever and surgical outcomes, as well as the effectiveness of perioperative anti-stress interventions.

Enhancing the frequency of temperature measurements could potentially improve fever detection rates; however, the practicality of such a method is low, incurring a substantial increase in medical workload for relatively little gain. Research has explored the employment of wireless sensors for continuous real-time monitoring of patients' body temperatures. These sensors, transmitting temperature data to a central processor at frequent intervals, offer a more precise reflection of temperature fluctuations [26, 27], which can facilitate prompt identification of postoperative complications [28]. Nonetheless, the functionality of these sensors is heavily dependent on reliable local network infrastructure and related devices. In settings bereft of sensor technology, alternative strategies must be considered. Harding et al. noted that fever patterns correspond to the diurnal variation in body temperature, peaking and troughing at consistent times, with night-time fever incidence in the emergency department exceeding morning rates by a factor of 2.5 [29]. Such findings imply that adjusting measurement timings could improve fever detection rates. However, the optimal intervals and frequency of temperature assessments for maximal fever detection efficacy are yet to be determined. This study gathered data on the hour from a continuous temperature dataset and systematically constructed various hypothetical measurement schedules, subsequently evaluating the fever detection rate of each regimen to ascertain the most effective timing for temperature checks.

Methods

Study Design and Participants

This is a retrospective cross-sectional study. Between November 29, 2020, and April 1, 2021, consecutive patients who aged 18 years or older, and underwent nonemergency gastrointestinal surgery were included. Patients who took immunosuppressive drugs within four weeks before surgery,who had used antibiotics or antipyretic analgesics in the week prior to admission, and patients who were pregnant. To avoid the interference of non-surgical related fever, we also excluded patients who presented with fever prior to surgery. Patients whose temperature data were missing for any reason were also excluded. Demographic characteristics, surgical types, length of hospital stay, and in-hospital complications were collected. The present study was approved by the local ethical committee. As a retrospective study, the requirement for informed consent was waived.

Body temperature measurement

Body temperature was continuously measured every four seconds by a wireless axillary thermometer (iThermonitor, Raiing Medical Company). The measurement accuracy of the sensor is 0.01℃, and the readings are consistent with those of mercury thermometers [30]. On admission, a hypoallergenic adhesive patch (Raiing Medical) was used to securely position the iThermonitor in the shaved axilla of the patient. The temperature data were transmitted to a repeater through low energy Bluetooth and then transferred to a central workstation, where the data were saved on an electronic monitoring panel. A detailed description of the technical parameters of the iThermonitor can be found in the supplementary material 1. The temperature data on the day of surgery were dismissed, and the temperature data of the next three days were retrieved and named the 1st, 2nd, and 3rd day temperatures.

Endpoints

Taking into consideration previous research reports and consensus outcomes, Fever was defined as a body temperature that exceeded 38.0℃ [5, 15-17]. Based on the definition of fever and the data conscientiously collected by the sensors, the fever incidence on each day of the first three days and the total fever incidence of the first three days were investigated.

Patients were divided into a fever group and a nonfever group, and the clinical outcomes were compared between the two groups. The correlation between fever on the first day and fever in the next two days was investigated.

Intermittent measurement simulation

In the simulated clinical temperature measurement analysis, we included all patients who were determined to have a fever based on sensor temperature data. In clinical practice, for ease of implementation and documentation, temperature measurements are typically taken on the hour.

Therefore, the temperature data on the hour every hour were selected from the consecutively collected data set.

A brute force strategy was used to list the fever detection rate of every possible measurement plans with varied measurement times per day. The simulated intermittent measurement plans, where every possible temperature measurement plan in clinical practice, including one to twenty-four time points, were composed of n time points from the 24 hours, such as C(24,1), C(24, 2), C(24, 3), C(24, 4), C(24, 6), C(24, 8), C(24, 12), and C (24, 24). If the temperature data at the whole hours included in the temperature measurement plan exceeds 38.0℃, it is considered that the clinical temperature measurement plan has detected a fever.

For example, C(24, 2) means diagnosing fever based on temperatures at any two time points of the 24 hours, such as 0:00 and 1:00, 0:00 and 2:00, or 0:00 and 3:00. The total number of combinations of C(24, 2) was 276. Fever was clinically diagnosed based on the temperature at the selected time points, and the fever detection rates of every plan with varied measurement times were listed and ranked.

Statistical Analysis

Temperature data processing, including the combination of the measurement timings, calculation of fever incidence, and calculation of fever detection rate, were managed by Python 3.7.3 (pandas 1.1.3, numpy 1.21.6). The statistical analysis was conducted by SPSS22.0. Categorical data are reported as numbers with proportions, and quantitative data are reported as the mean with standard deviation or, where appropriate, as the median with an interquartile range (IQR). Categorical data were compared using the chi-squared test or Fisher's exact test, where appropriate. For continuous data, Student's t test or Mann–Whitney U test were used. A two-sided p value of <0.05 was considered statistically significant. Because of the exploratory nature of this survey, the sample size calculation was not performed.

Results

Patients characteristics and clinical outcomes

A total of 147 patients who underwent gastrointestinal surgery were included. All the patients had complete temperature data within three days after surgery, and no missing values needed to be processed. Temperature data that were continuously collected by the sensor were used. Fever was detected in a total of 60 (40.82%) patients within three days after surgery. *Table 1* shows the demographic characteristics, surgical types, length of hospital stay after surgery, and in-hospital complications. The median age of the patients was 60 years, and 62.6% of the patients were male. The median length of hospital stay was 6 days (IQR, 5 to 8 days). Compared with the patients without fever within three days after surgery, febrile patients experienced a longer length of hospital stay (median 7 (IQR 6, 9) vs. median 6 (IQR 5, 7), p <0.001). No significant difference in the postoperative complication rate was found between patients with and without fever within the three days (8.3% vs. 6.9%, p=0.759).

Table 1. Patients characteristics.

	N=147	Fever (n=60)	No fever (n=87)	P value
Age (year), media(IQR)	60 (53, 67)	60.5 (56, 66)	58 (50, 69)	0.299[a]

Sex (male), n(%)	92 (62.6)	36 (60.0)	56 (64.4)	0.591[b]
Comorbidity				
Hypertension	28 (19.0)	12 (20.0)	14(16.1)	0.542[b]
Diabetes	11 (7.5)	4(6.8)	7(8.0)	1.000[c]
Coronary artery disease	12 (8.2)	5(8.3)	7(8.0)	1.000[c]
Laparoscopic surgery, n(%)	81 (55.1%)	34 (56.7)	47 (54.0)	0.751[b]
Surgery types, n(%)				0.153[c]
Esophagectomy	5 (3.4%)	2 (3.3%)	3 (3.4%)	
Gastrectomy	60 (40.8%)	32 (53.3%)	28 (32.2%)	
Colorectal resection	72 (49.0%)	24 (40.0%)	48 (55.2%)	
Small intestinal resection	7 (4.8%)	2 (3.3%)	5 (5.7%)	
pancreaticoduodenectomy	2 (1.4%)	0	5 (5.7%)	
Pancreatectomy	1 (0.7%)	0	1 (1.1%)	
Length of hospital stay, media(IQR)	6 (5, 8)	7 (6, 9)	6 (5, 7)	<0.001[d]
Complications, n(%)	11 (7.5)	5 (8.3%)	6 (6.9%)	0.759[c]
Pneumonia	4 (2.7)	2 (3.3%)	2 (2.3%)	
Intestinal obstruction	4 (2.7)	2 (3.3%)	2 (2.3%)	
Leakage	3 (2.0)	1 (1.7%)	2 (2.3%)	
Incision dehiscence	2 (1.4)	1 (1.7%)	1 (1.1%)	

[a] Student's t test, [b] chi-squared test, [c] Fisher's exact test, [d] Mann–Whitney U test

Fluctuation of body temperature and fever detection rate

The fluctuations in body temperature on the 1st, 2nd, and 3rd days after surgery are shown in *Figure 1a-c*. The mean body temperature ranged from 36.88°C to 37.24°C, and the mean body temperature in the first three days after surgery was 37.02°C, 37.08°C, and 37.06°C, respectively.

The average body temperature in one day is shown in *Figure 1d***,** and the body temperature varied throughout the day, with its nadir at 8:00 and its zenith at 23:00. *Figure 2* shows the fever detection rate by each hour. Within 24 hours, 38.33% fever was detected by taking measures at 19:00 and 20:00, and only 3.33% fever was detected by taking measures at 13:00.

Fever detection rate and measurement times

By using the intermittently picked temperature data on the hour, varied measurement plans were constructed and demonstrated. The highest and lowest detection rates and the measurement timings for the highest detection rate are shown in *Table 2*. Of the one-time model C(24, 1), which means fever was diagnosed by the temperature data at one time point per day, the fever detection rate ranged from 3.33% to 18.54%. Of the two times model C(24, 2), which means fever was diagnosed by the temperature data at two time points per day, the fever detection rate ranged from 6.67% to 31.16%. Of the three C(24, 3), four C(24, 4), and six C(24, 6) times models, the fever detection rate ranged from 6.67% to 65.00%, 8.33% to 70.0%, and 10.00% to 73.33%, respectively. When the measurement frequency was increased to hourly, the detection rate gradually reached a plateau of 85% (*Figure 3a*).

Table 2. Fever detection rates of body temperature measurement plans with varied measurement timings.

Measurement plans[#]	Fever detection rate[*] (%, 95%CI)		Measurement plan(s) with the highest detection rate
	Lowest	Highest	
C(24, 1)	3.33 (0.42, 6.23)	38.33 (30.47, 46.19)	19:00/20:00
C(24, 2)	6.67 (2.64, 10.70)	56.67 (48.66, 64.68)	3:00, 19:00/20:00
C(24, 3)	6.67 (2.64, 10.70)	65.00 (57.29, 72.71)	3:00, 20:00, 22:00/23:00
C(24, 4)	8.33 (3.86, 12.80)	70.0 (62.59, 77.41)	0:00, 3:00, 20:00, 23:00
C(24, 6)	11.67 (6.48, 12.86)	76.67 (69.83, 83.51)	0:00, 3:00, 6:00, 16:00, 20:00, 23:00
C(24, 8)	18.33 (12.08, 24.58)	80.00 (73.53, 86.47)	0:00, 1:00, 3:00, 5:00, 6:00, 16:00, 20:00, 23:00 et al. n=26
C(24,24)	85.0 (79.22, 90.77)		-
Plans in our ward			
Plan A	43.33 (40.25, 56.41)		6:00, 18:00
Plan B	48.33 (40.25, 56.41)		6:00, 10:00, 14:00, 18:00
Plan C	58.33 (50.36, 66.30)		6:00, 10:00, 14:00, 18:00, 22:00, 2:00

#: C (24, r), selecting r time points from the 24 hours in one day.

*: Fever detection rate = (detected febrile patients number) / (all febrile patients number) within three days after surgery

Fever detection rate and measurement timings

The detection rate of the intermittent approach is influenced by the measurement timings. *Table 2* shows that the corresponding time points of the top detection rates were distributed throughout the nighttime. For example, at 19:00/20:00 for C(24, 1), 3:00, 19:00/20:00 for C(24, 2), 3:00, 20:00, 22:00/23:00 for C(24, 3), and 0:00, 3:00, 20:00, 23:00 for C(24, 4), the detection rate also reached a plateau by taking measures at fewer specific time points (*Figure 3b*). For example, an 85.0% detection rate can also be achieved by using eleven time points: 0:00, 1:00, 3:00, 5:00, 6:00, 8:00, 16:00, 17:00, 20:00, 21:00, and 23:00 (supplementary material 2, line C(24, 11)). However, that is also cumbersome in real clinical work.

In our ward, according to the nursing grade, postoperative temperature is measured with three plans: Plan A (6:00, 18:00), Plan B (6:00, 10:00, 14:00, 18:00), and Plan C (6:00, 10:00, 14:00, 18:00, 22:00, 2:00). Based on the continuously collected data, the fever detection rate of these plans is 43.33%, 48:33%, and 58.33%, respectively. The optimal detection rate of plans with the same measurement times was 56.67%, 70.0% , and 76.67%, respectively. (Table 2)

Discussion

Principal Results

This is the first study to investigate fever detection rates by intermittent measurement. In the present study, every possible intermittent measurement plan with varied measurement timings was constructed, and the corresponding fever detection rates were calculated. The results showed that fever was less frequently detected by medical staff than by the sensors, and the upper limit of detection rates by intermittent measurement was 85% when body temperature was measured hourly. For measurement plans with varied daily frequencies, we can improve the detection rates by adjusting the measurement timings.

Limitations

While our findings have important implications, we acknowledge several limitations to our study. Firstly, this is a small-sample retrospective study; as such, its results may be subject to bias. Secondly, we included patients who had undergone gastrointestinal surgery; it remains to be verified whether patients who have undergone other types of surgery also exhibit similar postoperative body temperature characteristics, which would require validation in other patient cohorts; thirdly, the detection rates were calculated based on the assumption that temperature was measured on the hour. There may be better time points at which fever detection is highest. However, for convenience, body temperature is usually measured during the hour in clinical work, and our assumption is consistent with clinical practice. Fourthly, previous studies and our research both indicate that the incidence of febrile events decreases as the duration of hospitalization increases [31-33]. Given that our study had a small sample size, and febrile events became infrequent after three days, it was challenging to discern the differences across various temperature monitoring schedules. Therefore, we chose to analyze the time period during which the occurrence of febrile events was higher, and only body temperature within the first three days after surgery was recorded. Whether the selected time points that were determined in this study are applicable after three days remains to be determined in further studies. Fifthly, like most studies, we used a fixed threshold to define fever at different times. However, considering the variability of body temperature, it might be more reasonable to use a floating threshold to determine whether a patient is having a fever at different times. For instance, whether a body temperature exceeding 37.5℃ after waking up, or exceeding 37.0℃, should also be considered an abnormal state. Nonetheless, we currently lack a more rational method to define fever. Moreover, this issue goes beyond the interpretive scope of this study and requires further exploration in future research. In addition, body temperature is influenced by age, sex, and even weather [34]. However, stratified analysis was not performed since it is not practical to do so in the ward to define fever by varied levels.

Comparison with Prior Work

Consistent with a previous study which found that the proportion of febrile patients increased 2.4 to 3.6 times from morning to evening [29] , we also observed that the timings of the measurement plans with highest detection rates were predominantly at night. Moreover, as Figure 2 illustrates, the discrepancy between fever detection rates during the day and at night was more pronounced (38.33% at 19:00/20:00 versus 3.33% at 13:00). This can be explained by the circadian rhythm of human body temperature. It is well known that the body temperature fluctuates throughout the day [18], with potential fluctuations of up to 1.0℃ within a single day [35]. In our study, we also found that body temperature exhibited rhythmic variations in patients who underwent gastrointestinal surgery. Figure 1d demonstrates that patients' body temperatures after surgery tend to be higher at night and lower during daylight, with the minimum recorded at 8:00 and the maximum at 23:00. Hence, assessing fevers using temperature readings taken at various times throughout the day can lead to substantial discrepancies in conclusions.

Unfortunately, the timing of temperature monitoring is often neglected in both clinical research and practical settings. Notably, even in medical students' textbooks, there is no clear protocol for monitoring body temperature during the perioperative period. Medical centers tend to formulate postoperative temperature monitoring protocols based on customary local practices rather than standardized guidelines. This study demonstrates that our hospital's long-standing protocol has failed to effectively identify postoperative fever events. As indicated by Table 2, conducting as many as six temperature measurements daily only detected 58.33% of febrile patients.

If we adjust the temperature measurement times to 3:00, and 19:00 or 20:00, two daily measurem ents could still identify 56.67% of the cases. Optimizing the schedule to include checks at 0:00, 3:00, 6:00, 16:00, 20:00, and 23:00 could improve fever detection rates to 76.67%.

As with our usual practice, some studies on the clinical significance of fever are typically measured only at a few unreported times of the day [16, 17, 19, 20], while other studies do not show the timing of measurement [6, 9, 17, 21-25] . Assuming body temperature is measured hourly, there would be 24 time points per day, resulting in a vast array of measurement schedules. Given the wide range of detection rates among the numerous measurement schedules, many febrile patients might go unidentified when measurements are taken at randomly selected times. Since fevers cannot be accurately detected, the interpretation of the clinical significance of postoperative fever may also be biased. In addition, we also see some clinical studies that consider fever as an outcome of intervention, especially those related to Enhanced Recovery After Surgery (ERAS) strategies for perioperative stress control [8-14]. In these studies, the timing and frequency of temperature measurement are not reported either. If consistency of the timing of temperature measurements is not considered when assessing fever, biases are likely to occur when evaluating the efficacy of the respective clinical interventions. Therefore, we may consider including recommendations on the timing of temperature measurements in ERAS-related guidelines.

This study presents an appendix listing optimal measurement schedules that achieve the highest detection rates, varying from once to 23 times per day. By aligning these schedules with the routine practices of local hospitals, clinicians can formulate more precise thermometric protocols. For instance, a tri-daily measurement regimen might entail taking temperatures at 3:00, 20:00, and 22:00/23:00, as specified in Table 2, row C (24, 3). It is essential to recognize, however, that these proposed times are flexible rather than absolute mandates for fever surveillance. In clinical practice, temperatures will also be measured at any necessary time. Given the symptoms that accompany fever, it is reasonable to measure temperature at suggested times as well as when needed.

What is the clinical significance of detecting postoperative fever, especially fever that occurs in the early days following surgery? Many studies have investigated the correlation between postoperative fever and infection. Most have found that postoperative fever is a marker of infection with very low specificity and sensitivity [2, 5] . Some researchers have reported that among patients who developed fever after abdominal surgery, only 2% had positive blood cultures [5]. Among patients with fever following orthopedic surgeries, the positive finding rates for chest X-rays, urinalysis, urine cultures, and blood cultures were 0.3%, 28.5%, 10.9%, and 3.5%, respectively. Such low cost-effectiveness has led some researchers to question the utility of postoperative temperature measurement [36]. One study even instructed the clinical team responsible for patient care to remain unaware of the patient's body temperature and required clinical decisions to be made without looking at temperature data. This study reported a positive predictive value of merely 8% for fever as an indicator of infection, suggesting the potential abandonment of routine temperature measurements [17]. Our findings align with these observations, demonstrating an insignificant link between fevers within the first three postoperative days and the onset of complications.

Although the prevalence of postoperative fever may not require immediate imaging or bacteriological assessments, it is inadvisable to ignore it and leave patients to manage the condition without support. The risks posed by postoperative fever extend beyond infection. Postoperative fever is also associated with the release of inflammatory mediators in the absence of infection. This study indicates that fever during the early postoperative days has a positive correlation with prolonged hospital stays (with a median of 7 days, IQR 6-9 days, compared to a median of 6 days, IQR 5-7 days). The longer hospitalization might attributable to surgical stress, as a fever following surgery may arise from inflammation and tissue damage [37], suggesting that patients enduring pronounced surgical stress may need additional recovery time. Monitoring for postoperative fever is crucial in evaluating the magnitude of surgical stress and the efficacy of interventions to mitigate it. Fever, as a surgical stressor, constitutes a postoperative adverse event and an unpleasant experience that necessitates closer nursing attention. Considering the benign nature of early fever, there might be two approaches: refraining from intervention and allowing the fever to subside on its own, or providing necessary medical care, such as pain management [38], physical cooling, physical examinations, and psychological comfort to facilitate the recovery process. If we opt to take some action, routine ward rounds could be considered during peak fever times, such as between 19:00 and 20:00.

Conclusions

In conclusion, reliance on traditional, arbitrary temperature measurement can lead to the oversight of numerous febrile episodes. From the standpoint of both clinical safety concerning fevers and the interpretability of clinical research, it is necessary to improve the detection rate of postoperative febrile events. Even in medical settings where continuous temperature monitoring sensors are unavailable, adjusting the timing for measuring temperatures to the nighttime can substantially improve the detection of febrile events. Postoperative body temperature monitoring protocols can be revised in accordance with the working habits of local hospitals. Additionally, to facilitate more precise assessments of study outcomes, future research examining postoperative fevers should consider detailing the timing of temperature recordings in their reports.

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Conflicts of Interest

None declared

X

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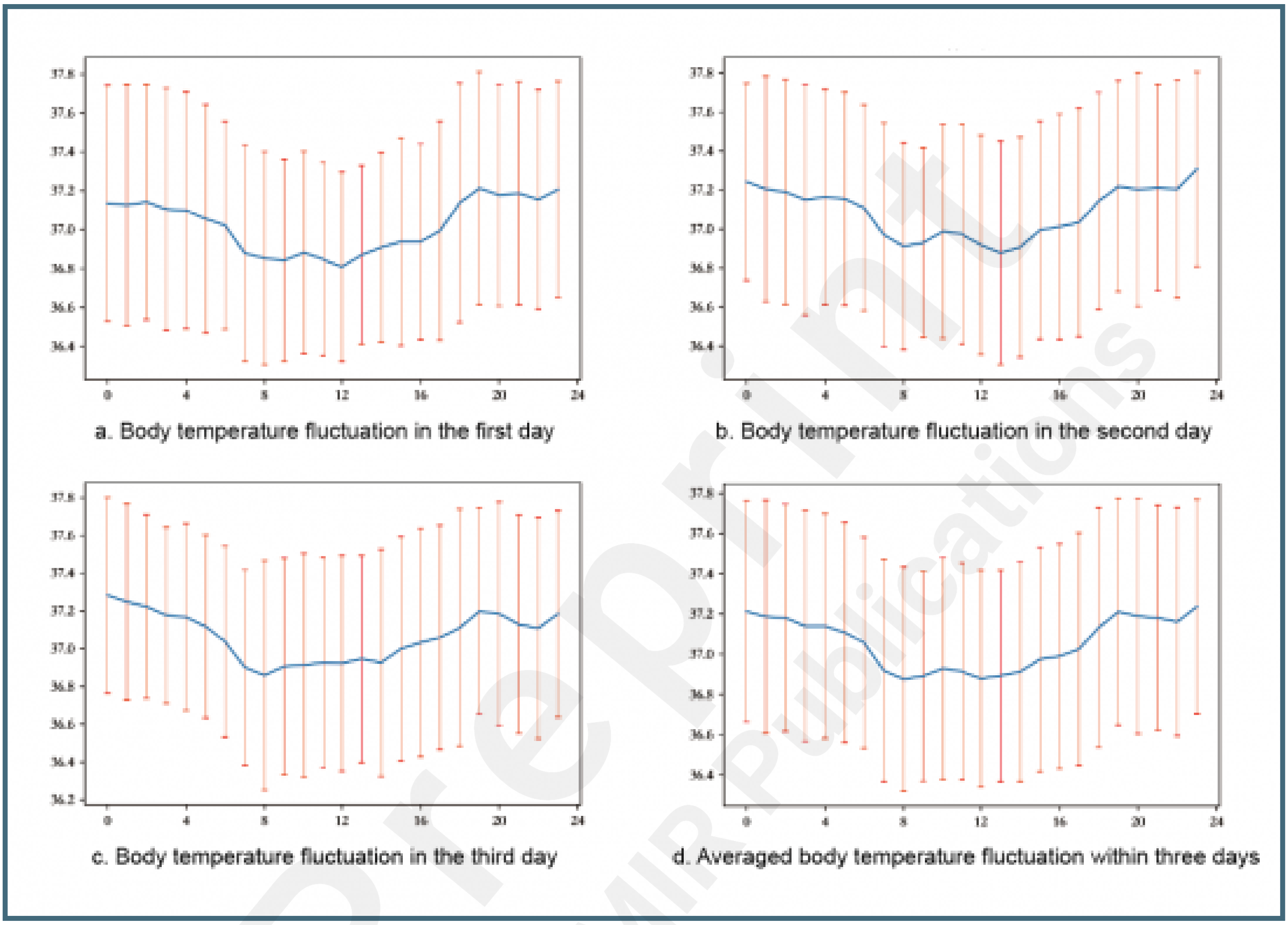
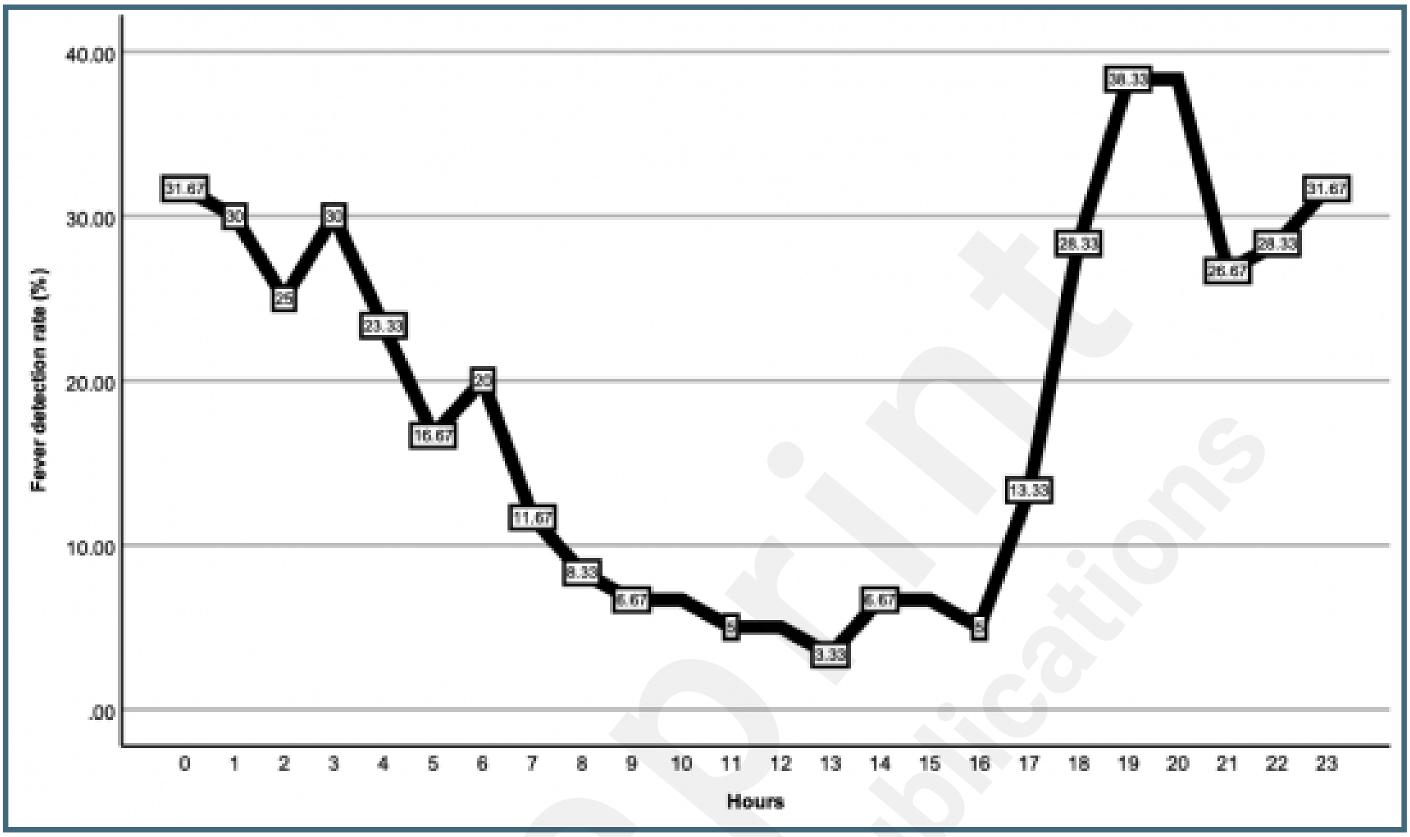
Supplementary Files

Figures

Body temperature curve after gastrointestinal surgery. a-c, Body temperature fluctuations on the first, second, and third days after surgery. The average body temperatures in the first three days after surgery were 37.02°C, 37.08°C, and 37.06°C, respectively. d, Average body temperature within 24 hours. The average body temperature bottomed out at 8:00 and peaked at 23:00.



Fever detection rate on each hour The vertical axis represents the fever detection rate, and the abscissa axis represents the hours. The fever detection rate peaked at 38.33% at 19:00 and 20:00 and reached a nadir of 3.33% at 13:00.



Correlation between fever detection rate and measurement times. The vertical axis represents the fever detection rate, and the abscissa axis represents the measurement times. The blue, orange, and green lines show the fever detection rates on the first, second, and third days after surgery, respectively. The red line shows the fever detection rate within three days. a the averaged fever detection rates with varied time points, b the highest detection rates with varied time points.