Comparison of temporal artery temperature and bladder temperature in the postanesthesia care unit

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ABSTRACT

To verify that temporal artery (TA) temperature measured in the postanesthesia care unit (PACU) in noncardiac surgical patients is a valid reflection of core temperature, a prospective, observational, institutional review board–approved study was conducted in a large, academic tertiary care hospital. The study developed from an initial quality improvement project. A total of 276 patients who had an indwelling bladder catheter as standard of care were enrolled when a research student was available over a 6-month period in 2015. Infrared TA temperature was measured (average of three readings) simultaneously with bladder temperature on PACU arrival. Mean temperature in the bladder and TA groups was $>36^{\circ}\text{C}$ with a clinically negligible difference (0.125°C ; 90% confidence interval, $0.059\text{--}0.192$). Agreement between bladder and TA temperatures, as well as between bladder and last operating room temperatures, was $>95\%$ by Bland-Altman analysis. A properly performed TA temperature measure on PACU arrival is an acceptable representation of core temperature for purposes of quality assessment, patient comfort, and regulatory requirements.

KEYWORDS Bladder temperature; postanesthesia care unit; temporal artery temperature

Temperature measurement in the postanesthesia care unit (PACU) is important for patient comfort and quality. Current guidelines require patients who undergo procedures lasting >60 minutes to achieve temperature $>36^{\circ}\text{C}$ within 15 minutes after anesthesia.¹ The Centers for Medicare and Medicaid Services has indicated that perioperative temperature is a high-priority measure.² Prevention of hypothermia-related complications is important, with one study showing a difference of 1.1°C between the Surgical Care Improvement Project–compliant group ($36.6^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$) compared to the noncompliant group ($35.5^{\circ}\text{C} \pm 0.5^{\circ}\text{C}$).³ This is significant given the adverse effects of hypothermia.⁴ Although core temperature measures may be more accurate in the PACU,³ temporal artery (TA) temperature measures are convenient and less invasive. This study was a quality improvement initiative conducted in a manner similar to that of a recent evaluation of wireless axillary temperature.⁵

METHODS

Institutional review board approval was granted with waiver of consent given the absence of patient identifiers and standard clinical care. Adults in the PACU of an academic tertiary care hospital who underwent general anesthesia during 6 months in 2015 were enrolled on weekdays when a research associate was available. Subjects had a bladder catheter in place, and no catheter was placed for study purposes. The Foley bladder catheter was connected to the PACU monitor (GE CDA15T). Infrared TA cutaneous temperature was recorded with a mean of three readings. Data on patient demographic characteristics (gender, age, physical status classification, body mass index), time from last operating room (OR) temperature reading, and site of OR temperature were recorded.

Although an *a priori* power analysis was not performed, this is one of the largest reported temperature studies for the PACU. A prior study suggested 0.5°C as a meaningful margin of equivalence,⁵ so 90% confidence intervals for the

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difference between bladder and TA temperature within $\pm 0.5^{\circ}\text{C}$ were used. The Kolmogorov-Smirnov test was used to determine normal distribution. Body mass index distribution was skewed and summarized as median and interquartile range. Continuous variables were normally distributed and reported as mean $\pm$ standard deviation. Agreement between bladder and TA temperatures and between bladder PACU and last OR temperature was evaluated with Bland-Altman analysis with 95% limits of agreement.

RESULTS

A total of 282 patients were enrolled; five had incomplete records and one was excluded with an isolated OR

temperature of 41°C , leaving a cohort of 276, which was predominantly female, middle-aged, and nonobese (Table 1). Bladder was the most common site of intraoperative measurement (Table 1), and time between last OR and PACU measurement was 33.2 ± 24.4 minutes.

Bladder and TA PACU temperatures were similar; when compared to the last recorded OR temperature (Table 2), the differences were within 0.2°C , narrower than the selected 0.5°C . In subgroup analysis, those with OR bladder temperature ($n = 196$) had similar demographics (Table 1). Bladder and TA PACU measures were similar, with differences within the 0.5°C limit of equivalence (Table 2). In Bland-Altman analysis, 95.4% of the difference between bladder and TA PACU was within agreement limits (-0.899 to 1.089), and bias was 0.095 , indicating excellent agreement (Figure 1a). For bladder PACU and last OR temperatures, 95.9% of the difference was within agreement limits (-1.144 to 1.468), and bias was 0.162 (Figure 1b).

DISCUSSION

In this large, single-center, prospective evaluation of routine temperature measurement, bladder and TA temperatures were similar on arrival to the PACU and to the last OR temperature.

Prevention of intraoperative hypothermia avoids adverse effects⁶ and requires accurate temperature measurement,^{2,7} although frequent discontinuation of monitoring is reported.⁸ Bladder temperature is accurate in the absence of extremes, as in this noncardiac cohort.⁹ Agreement of bladder and cutaneous temperature devices was previously reported (50 patients), although no site was consistently within 0.5°C of bladder measures.¹⁰ The TA instrument used in our study had reasonable correlation. In a neurosurgical study involving 36 patients, TA measure limits of agreement were $>0.5^{\circ}\text{C}$.¹¹ In cardiac surgery, an infrared forehead thermometer performed poorly ($>0.5^{\circ}\text{C}$ difference) in 15 adults with fever after cardiopulmonary bypass.¹² In a meta-analysis and two further studies, TA thermometry was unreliable for measuring core temperature, particularly in febrile and surgical patients.^{13–15}

In contrast, our large, single-center study suggests that TA temperature is equivalent to core body temperature in postoperative noncardiac surgical patients and is accurate for

Table 1. Patient characteristics

Variable	Total cohort (<i>n</i> = 276)	Bladder temperature measured in OR (<i>n</i> = 196)
Age (years, mean $\pm$ SD)	51.8 $\pm$ 16.7	52.1 $\pm$ 16.8
BMI (kg/m ²), median (IQR)	29.2 (24.6–33.2)	28.9 (24.4–33.7)
Men	111 (40%)	84 (43%)
ASA PS		
1	3 (1%)	1 (0.5%)
2	81 (29%)	47 (24%)
3	160 (58%)	123 (63%)
4	24 (9%)	17 (9%)
Unknown	8 (3%)	8 (4%)
OR temperature measurement site		
Bladder	196 (71%)	
Nasal	50 (18%)	
Esophagus	16 (6%)	
Axilla	8 (3%)	
Unknown	6 (2%)	

ASA PS indicates American Society of Anesthesiologists physical status; BMI, body mass index; IQR, interquartile range; OR, operating room.

Table 2. Temperatures in the OR and PACU

Variable	Mean $\pm$ SD ($^{\circ}\text{C}$)	
	Total cohort (<i>n</i> = 276)	Bladder temperature measured in OR (<i>n</i> = 196)
Last temperature in OR	36.19 $\pm$ 0.72	36.22 $\pm$ 0.72
Bladder temperature in PACU	36.24 $\pm$ 0.83	36.31 $\pm$ 0.79
TA temperature in PACU	36.12 $\pm$ 0.50	36.15 $\pm$ 0.49
Bladder temperature in PACU – last OR temperature (90% CI)	0.057 $\pm$ 0.527 (0.004–0.109)	0.095 $\pm$ 0.507 (0.035–0.155)
Bladder temperature in PACU – TA temperature in PACU (90% CI)	0.125 $\pm$ 0.673 (0.059–0.192)	0.162 $\pm$ 0.667 (0.083–0.241)

CI indicates confidence interval; OR, operating room; PACU, postanesthesia care unit; SD, standard deviation; TA, temporal artery.

Figure 1. Bland-Altman analysis for (a) postanesthesia care unit bladder vs temporal artery temperatures (bias = -0.095) and (b) bladder operating room vs bladder postanesthesia care unit temperatures (bias = 0.162).

clinical and regulatory requirements. Our robust sample size may account for the absence of relevant differences. Prior studies were all much smaller, and their findings of poorer performance of TA temperature may reflect limited sample sizes. Our findings are reassuring for continued clinical use of TA measurement in the PACU and reinforce our current protocol for temperature measurement.

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