

Supplemental data

Definition of Root mean square difference

$$A_{\text{RMS}} = \sqrt{\frac{1}{n} \sum_{j=1}^n (y_j - \hat{y}_j)^2}$$

A_{RMS} : root mean square difference;

n : number of samples;

y_j : Pulse oximeter measurement;

\hat{y}_j : Reference standard measurement

We squared the difference (either positive, negative or 0) between a pulse oximeter measurement and the reference standard measurement. Then we calculated the mean of the sum of squares, and determined the root of that mean. As the difference between the pulse oximeter and the reference standard is squared, the A_{RMS} is always positive.

Definition of Mean absolute error

$$\text{MAE} = \frac{1}{n} \sum_{j=1}^n |y_j - \hat{y}_j|$$

MAE : mean absolute error;

n : number of samples;

y_j : Pulse oximeter measurement;

\hat{y}_j : Reference standard measurement

We calculated the absolute difference (either positive or 0) between a pulse oximeter measurement and the reference standard measurement. We then determined the mean of these absolute differences. Similarly to the A_{RMS} , the MAE is always positive, as it concerns an absolute difference.

References

Kampakis, S. Performance measures RMSE MAE. 2020 [cited 2020 01-10-2020]; Available from: <https://thedata scientist.com/performance-measures-rmse-mae/>.

Lipnick, M.S., The Accuracy of 6 Inexpensive Pulse Oximeters Not Cleared by the Food and Drug Administration: The Possible Global Public Health Implications. *Anesthesia and Analgesia*, 2016. 123(2): p. 339-344.

Table S1. Accuracy of pulse oximeters in detecting abnormal oxygenation status, using either $\text{SaO}_2 \leq 92\%$ or $\text{SaO}_2 \leq 94\%$ as threshold

SaO₂ ≤ 92%	Pulse oximeter	TP/FN	FP/TN	Sensitivity	Specificity	PPV	NPV	Accuracy
	AFAC FS10D	19/6	66/141	76 (55-91)	68 (61-74)	22 (18-28)	96 (92-98)	69 (63-75)
	AGPTEK FS10C	18/7	64/144	72 (51-88)	69 (63-75)	22 (17-28)	95 (92-97)	70 (63-75)
	ANAPULSE ANP 100	18/5	76/103	78 (56-93)	58 (50-65)	19 (15-24)	95 (90-98)	60 (53-67)
	Cocobear	22/1	90/113	96 (78-100)	56 (49-63)	20 (17-23)	99 (94-100)	60 (53-66)
	Contec CMS50D1	13/12	34/169	52 (31-72)	83 (77-88)	28 (19-38)	93 (90-96)	80 (74-85)
	HYLOGY MD-H37	21/4	79/128	84 (64-95)	62 (55-68)	21 (17-25)	97 (93-99)	64 (58-70)
	Mommed YM101	18/7	52/152	72 (51-88)	75 (68-80)	26 (20-33)	96 (92-98)	74 (68-80)
	PRCMISEMED F4 PRO	15/9	64/145	63 (41-81)	69 (63-76)	19 (14-25)	94 (91-96)	69 (62-75)
	PULOX-PO-200	20/5	52/154	80 (59-93)	75 (68-81)	28 (22-34)	97 (93-99)	75 (69-81)
	Zacurate Pro Series 500DL	15/7	37/153	68 (45-86)	81 (74-86)	29 (21-38)	96 (92-98)	79 (73-85)
SaO₂ ≤ 94%	AFAC FS10D	64/6	76/86	91 (82-97)	53 (45-61)	46 (41-50)	93 (87-97)	65 (58-71)
	AGPTEK FS10C	62/8	71/92	89 (79-95)	56 (48-64)	47 (42-51)	92 (86-96)	66 (60-72)
	ANAPULSE ANP 100	60/5	102/35	92 (83-97)	26 (18-34)	37 (34-40)	88 (74-94)	47 (40-54)
	Cocobear	71/2	88/71	97 (90-100)	45 (37-53)	45 (41-48)	97 (90-99)	61 (55-68)
	Contec CMS50D1	55/15	41/117	79 (67-87)	74 (66-81)	57 (50-64)	89 (83-93)	75 (69-81)
	HYLOGY MD-H37	67/3	86/76	96 (88-99)	47 (39-55)	44 (40-48)	96 (89-99)	62 (55-68)
	Mommed YM101	60/9	56/104	87 (77-94)	65 (57-72)	52 (46-57)	92 (86-96)	72 (65-77)
	PRCMISEMED F4 PRO	57/12	75/89	83 (72-91)	54 (46-62)	43 (38-48)	88 (81-93)	63 (56-69)
	PULOX-PO-200	62/7	70/92	90 (80-96)	57 (49-65)	47 (42-52)	93 (87-96)	67 (60-73)
	Zacurate Pro Series 500DL	55/9	45/103	86 (75-93)	70 (62-77)	55 (48-61)	92 (86-95)	75 (68-80)

The values for PPV, NPV and accuracy are dependent on disease prevalence

TP= true positive, FP= false positive, FN= false negative, TN= true negative, PPV= positive predictive value, NPV= negative predictive value.

Table S2. Factors associated with poor performance of each pulse oximeter

Pulse oximeter	Associated factor(s)	Beta	Std Error	P-value
AFAC FS10D	Heart rate bias	0.04	0.01	0.002
	Systolic blood pressure	0.04	0.01	0.005
AGPTEK FS10C	Heart rate bias	0.04	0.01	0.002
	Fitzpatrick scale IV-VI	1.96	0.93	0.04
ANAPULSE ANP 100	None	-	-	-
Cocobear	Systolic blood pressure	0.03	0.02	0.03
	Fitzpatrick scale IV-VI	2.30	1.21	0.05
Contec CMS50D1	Cold hands to touch	1.59	0.77	0.04
HYLOGY MD-H37	Fitzpatrick scale IV-VI	3.07	1.13	0.007
Momed YM101	Heart rate bias	0.04	0.01	<0.001
	Systolic blood pressure	0.03	0.01	0.006
	Fitzpatrick scale IV-VI	2.40	0.82	0.004
PRCMISEMED F4 PRO	Cold hands to touch	2.69	1.03	0.01
	Heart rate bias	0.06	0.02	0.002
PULOX-PO-200	Cold hands to touch	1.60	0.62	0.01
	Systolic blood pressure	0.03	0.01	0.006
Zacurate Pro Series 500DL	Heart rate bias	0.06	0.02	0.002
	Fitzpatrick scale IV-VI	2.34	1.1	0.038

Performance of each pulse oximeter was based on bias ($SpO_2 - SaO_2$), a continuous metric. Included variables in logistic models were: age (years), sex, Fitzpatrick scale (I-III vs IV-VI), heart rate bias (difference between pulse oximeter heart rate and true heart rate as captured by ICU monitor), body temperature (degrees C), cold hands to touch (yes/no), systolic blood pressure (mmHg), and use of vasopressor drugs (yes/no).

Figure S1. Bland-Altman plots of performance of pulse oximeters (bias compared with SaO₂)

