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Assessment of Manual Pulse Calculations at Varying Time Intervals: A Clinical Test Accuracy Original Article

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Abstract

Background: Pulse measurement and heart rate are one of the most basic medical skills and yet, is the most important skill that has be learned by all medical professionals. The duration of how long that should be measured is variable depending on the learning of individual medical student. Aim: To assess accuracy of pulse calculation done manually to decide the cutoff on how long pulse should be measured. Methodology: An observational study was conducted after due IRB permission where included patients' pulse was calculated for different time intervals and extrapolated to calculate the beats per minute. At the same time, patient's pulse was taken by a calibrated pulse oximeter 6 times during that 1 minute. Average of the Oximeter data was compared against the extrapolated data was compared for their averages and standard deviation across all time fields using T-test and statistical significant difference was found. Result: Presence of statistical difference between the extrapolated data and oximeter data represents that calculating pulse for that long actually yields statistically significant deviation. Calculating pulse for 12 seconds and extrapolating it yields p-value of 0.0002 representing a significant difference but calculating higher than 12, i.e., for 15 seconds and then extrapolating yields p-value of 0.0612 which represents a nonsignificant difference compared to average oximeter pulse reading. Conclusion: This research paper although simple has been a way to answer the age old question on how long pulse should be measured. This concludes that any measurements higher than 15 seconds does yield a nonsignificant difference. Hence, the pulse should at least be measured for 15 seconds or higher.

Keywords: heart rate; radial pulse; oximetry; reproducibility of results; diagnostic techniques; cardiovascular

Introduction

Pulse, also known as heart rate, is the number of times the heart compresses per minute. It is the intermittent expansion and elongation of arteries produced by the pressure changes during the cardiac cycle[1]. It is usually felt over the radial artery. It represents the cardiovascular health of a person. Examination of pulse provides physiological data like work of the heart, circulatory state, and hemodynamics like blood volume and pressure, condition of blood vessels, etc. With each ventricular contraction, blood is pumped into the aorta, along with which a pressure wave is generated in the vessel wall, which is palpated as a pulse. A normal resting heart rate for a person is 60-100 beats per minute[2]. Manually, the pulse is calculated by the finger method. The middle finger is used to feel the pulse. The proximal finger is compressed to enhance the feeling of pulse in the middle finger, which can help determine the force and tension of the pulse and the condition of the arteries. The distal finger is kept pressed to stop the retrograde pulse produced by the ulnar artery and transmitted through the palmar arch[1].

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The unwritten rule in medicine is to palpate the pulse for a full 60 seconds and measure the pulse rate[3]. Although advocated for and advised for, this is not possible in the clinical setting, and this leads to challenges with the standardization of how long you should measure the pulse[4]. Some experts say that measuring it for 10 seconds and multiplying it by 6 gives the correct estimate, while others believe that measuring it for 20 seconds and multiplying it by 3 gives the correct estimate. The usual intervals used in practice are of 6, 10, 12, 15, 20, 30, and 60 seconds, and the pulse rate is calculated by multiplying the counts by the multiplier.

The lack of standardization here leads to issues arising like PVCs, missed beats, delays, and inaccuracy in general, which might lead to a change in the treatment of the patient and can cause a significant effect on the life of the patient[5]. Hence, a standard rule was required on how long you can measure the pulse count and multiply it to get the pulse rate, and not be statistically significantly different from the actual pulse rate you would have measured if you used the most commonly used method of pulse oximetry.

This study is being conducted to calculate pulse at different time intervals, i.e., at 6,10, 12, 15, 20, 30, and 60 seconds, to understand the pulse variability at different time intervals. Nowadays, in clinical practice, pulses are mostly calculated by pulse oximeters. But there are certain clinics or hospitals where pulse oximeters might not be available. In such scenarios, the pulse is calculated manually. The pulse obtained by the above-mentioned method, that is, by multiplying by an integer, is a shorter and quicker method, but may not give an accurate result. Thus, this study aims at recognizing the time interval at which the pulse calculation gives a near-exact pulse count of a patient.

Methodology

This was an observational study, and permission from the IRB was obtained prior to executing it. An informed consent form was explained to the patient in their vernacular language and signed by them. It was conducted at a tertiary care hospital. Pulse data from patients who came into the OPD and patients who were admitted were taken. Their pulse was recorded at different time intervals of 6, 10, 12, 15, 20, 30, and 60 seconds as mentioned in the supine position and multiplied by the appropriate multiples, respectively, to get the per-minute pulse rate. A total of 435 patients participated in this study: both male and female, ranging from the age group of 8 years to 88 years old. Pulse oximeter data were considered to check the accuracy of the manual data collected at different time intervals. Pulse oximeter data was also taken every 10-second interval for 1 minute, and its average was considered as the reference standard for comparison with the interval rate for better accuracy.

Inclusion Criteria:

- Patients whose Radial Pulse can be palpated and calculated
- Patients who are willing to give consent for the study

Exclusion Criteria:

- Patients with R-R delay

After data was collected and average calculations for the reference standard from each patient were done, Mean and Standard Deviation were calculated along with Confidence Interval 95 ranges. A paired t-test with the gold standard was used to compare the accuracy of each time interval pulse calculation, and the Mean rank table was employed to show the interval efficacy. Software like Excel and SPSS was used to conduct analysis.

A statistically significant difference with these reference standards would mean that time interval values differ greatly from the reference standard. Hence, pulse for that interval should not be taken to a multiplier and have a final rate, as the results then will vary statistically from the actual pulse. Correlation Coefficient were also used to understand the variability in each measurement.

P-value at 0.05 would be used as the level of significance.

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Results

Table 2: showing the Average pulse rate(per min) of all 435 participants at different time intervals and results of t-test against the reference standard Pulse Oximeter average as well as Pearson Correlation Coefficient with Pulse Oximeter. P-value cutoff was taken at 0.05; values less than that meant a significant difference between the two groups.

Table 1. Demography of the participants.

Total Sample Size N = 435			
Females		Males	
N = 156	Avg = 45.730	N = 279	AVG = 43.047
Minimum Age	8 years	Minimum age	10 years
Maximum Age	85 years	Maximum age	88 years

Table 2. Average Pulse Rate (N = 435 for all groups).

Pulse taken for	**Average ± CI95**	**PP-value for t-test (vs Pulse Ox)**	**Correlation coefficient (vs Pulse Ox)**
6 secs	88.897 (87.458 ± 90.335)	<0.0001	0.856
10 secs	84.814 (83.449 ± 86.179)	0.0008	0.895
12 secs	85.276 (83.87 ± 86.681)	0.0002	0.895
15 secs	83.32 (81.933 ± 84.706)	**0.0612**	0.901
20 secs	81.83 (80.49 ± 83.17)	**0.6868**	0.908
30 secs	80.625 (79.281 ± 81.97)	**0.4209**	0.908
60 secs	80.828 (79.49 ± 82.165)	**0.545**	0.952
Pulse Oximeter AVG	**81.43 (80.022 ± 82.838)**		**1.000**

There are a total of 435 participants in this study, consisting of 156 females and 279 males, whose radial pulse has been recorded in the supine position as shown in Table 2. Considering the p-value to be 0.05, any p-value less than that is considered to be significantly different. Pulse taken at 6 sec, 10 sec, and 12 sec have values of <0.0001, 0.0008, 0.0002, respectively, which are lower than the cut-off of 0.05, indicating it is statistically different from the reference standard. But pulses taken at 15 sec, 20 sec, 30 sec, and 60 sec have p-values of 0.0612, 0.6868, 0.4209, and 0.545, respectively, which are higher than the cut-off of 0.05, meaning the pulse calculated here is not statistically different from the reference standard.

As seen in the graph, the average pulse rate seen at 6 sec, 10 sec, and 12 sec are much higher compared to the average seen in the pulse oximeter, whereas the average pulse rate seen at 15 sec, 20 sec, 30 sec, and 60 sec, respectively, intersect within the range of the average pulse rate of the pulse oximeter.

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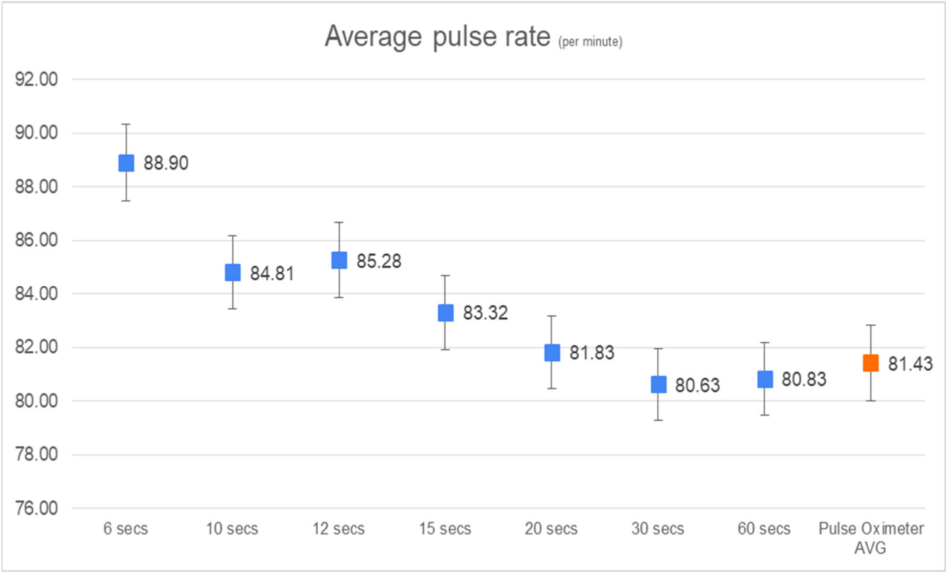

Graph 1. Box and whisker plot to demonstrate the Average pulse rate for each group and the confidence interval range as mentioned in Table 2. The Values of the Pulse Oximeter Average were considered as the reference standard, and every other group was compared against it.

Discussion

The assessment of the radial pulse is a fundamental clinical skill, yet the optimal duration for manual palpation remains a subject of debate between academic standards and clinical practicality[6,7]. The "gold standard" of a full 60-second count is often deemed impractical in high-volume settings, leading to the widespread use of shorter intervals[3]. This study of 435 participants aimed to validate the accuracy of these shorter intervals against a pulse oximetry reference standard.

Results demonstrate a clear threshold of accuracy at the 15-second interval. Pulse rates calculated from 6, 10, and 12-second intervals showed statistically significant deviations from the reference standard ($p < 0.05$), with the 6-second interval showing the most extreme variance ($p < 0.0001$). This inaccuracy is likely attributable to the "multiplier effect," where shorter observation windows exponentially increase the error margin of a single missed beat[4]. When a count is taken over a very short duration, such as 6 seconds, a single missed or extra beat, common due to human reaction time or minor sinus arrhythmia, is multiplied by a factor of 10. This magnifies a minor counting error into a clinically significant discrepancy of 10 beats per minute.

Conversely, intervals of 15, 20, 30, and 60 seconds yielded results that were not statistically significantly different from the pulse oximeter average ($p > 0.05$). Notably, the 15-second count (multiplied by 4) achieved a p-value of 0.0612, suggesting it is the minimum duration required to achieve clinical reliability in this cohort. These findings support the hypothesis that while ultra-short assessments (≤12 seconds) compromise data integrity, the 15-second assessment offers an acceptable balance between accuracy and time efficiency for patients with regular rhythms.

Standard nursing and medical textbooks often advocate for a 30-second or 60-second count to ensure accuracy[7,8]. However, this study suggests that for patients in sinus rhythm, a 15-second count is statistically non-inferior to the gold standard. This has significant workflow implications for busy outpatient departments (OPD) and triage settings, where reducing assessment time without compromising vital sign accuracy is paramount.

Several limitations must be considered when generalizing these findings. First, the study was conducted with patients in the supine position; accuracy may vary in standing or sitting positions where autonomic adjustments typically increase heart rate variability[4]. Second, and most critically, patients with "R-R delay" (arrhythmias) were explicitly excluded from the study. Consequently, the validity of the 15-second interval applies strictly to patients with regular heart rhythms. In clinical

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practice, a short interval may fail to detect the irregular-irregular pattern of atrial fibrillation or frequent premature ventricular contractions[8]. Therefore, while a 15-second count is adequate for rate calculation in sinus rhythm, it should not replace a longer auscultation or palpation if an irregularity is initially felt.

Conclusions

This study resolves the ambiguity regarding the minimum necessary time for manual pulse checks in patients with regular rhythms. It can be concluded that intervals shorter than 15 seconds lead to statistically significant errors and should be abandoned. A 15-second manual count, multiplied by four, or calculation for more seconds and multiplied by a smaller multiplier provides a reliable estimate of heart rate that is comparable to pulse oximetry, offering an evidence-based compromise for rapid clinical assessment.

Declarations: The authors have no conflict of interest and no financial gain from the paper or its publication. No financial support or funds will be taken for this research. The research will only be conducted after obtaining approval from the relevant ethics committee.

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