University of Colorado Hospital
ANSCHUTZ MEDICAL CAMPUS

Durability of Two Disposable Pulse Oximeter Sensor Designs

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ABSTRACT

Background. Two different models of disposable SpO_2 sensors (Philips and Nellcor) were evaluated for durability and ease of use. Both sensor brands were provided to the MICU and the Step-Down Unit at the University of Colorado Hospital. The Philips disposable sensor was the M1131A Adult/Pediatric SpO2 Sensor. The Nellcor disposable sensor was OxiMax MAX-A Adult O_2 Sensor.

Methods A Philips IntelliVue MP70 monitor was used with both brands of sensors. Nurses recorded the following information every 12-hour shift for each of their patients on pulse oximetry monitoring: 1) Brand of sensor used; 2) When pulse oximetry monitoring was started; 3) Number of new sensors placed on the patient during each shift, and if so, the reason for applying any new sensor; 4) Whether the sensor was moved to another site, and if so, why, and whether it was easy to reuse; 5) Effect of adhesive on the patient's skin (damage, etc.); 6) Overall ease of use. After patient data collection was complete a follow-up survey was administered to the nursing staff to investigate their routine practice in the use of disposable sensors, and their impressions of the ease of use of the two sensor types.

Results. The total number of patients in the study was 133; 67 patients were started with the Philips sensor and 66 patients were started with the Nellcor sensor. The average patient stay was 3 days, with the maximum stay 15 days and the minimum stay 1 day. The total number of sensors changed was 19 for Philips and 37 for Nellcor. The primary reason for a sensor change for either brand was failure of the adhesive tape (i.e., loss of adhesiveness or wadding of the tape).

Conclusion. The Philips sensor was changed approximately half as many times as the Nellcor sensor. Since US list price for both sensors is similar, use of the Philips sensor would produce a 50% reduction in pulse oximetry expenditure.
The post-study survey also showed that 78% of the nurses preferred the Philips sensor.

Key Words: SpO_2 sensor durability, disposable SpO_2 sensor, pulse oximeter sensor, pulse oximetry probe, pulse oximetry, pulse oximetry monitoring, SpO_2 monitoring, single-patient SpO_2 sensor, Philips SpO_2 sensor, Nellcor SpO_2 sensor

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INTRODUCTION

Many healthcare institutions today choose to use disposable adhesive sensors to decrease cross-contamination and improve wear-ability (low profile of sensor & decreased sensor displacement). Two significant shortcomings of disposable adhesive sensors are durability and incorrect sensor placement (poor emitter/detector alignment which can result in inaccurate readings).[1,2,3]

A recent addition to disposable sensors available in the market is a single patient sensor designed to improve on drawbacks of the commonly used band-aid type sensor. The purpose of this study was to compare this new sensor design to a standard disposable adhesive sensor.

As part of a Product Evaluation process at the University of Colorado Hospital, two different models of disposable SpO_2 sensors (Philips and Nellcor) were evaluated for durability and ease of use. Both sensor brands were provided to the MICU and the Step-Down Unit. The new sensor design in this study was the Philips disposable sensor (M1131A Adult/Pediatric SpO_2 Sensor). The standard band-aid type sensor was the Nellcor disposable sensor (OxiMax MAX-A Adult O_2 Sensor).

METHODS

Both brands of sensors were used with a Philips IntelliVue MP70 monitor. Nurses recorded the following information every 12-hour shift for each patient on pulse oximetry monitoring: 1) Brand of sensor used; 2) When pulse oximetry monitoring was started; 3) Number of new sensors placed on the patient during each shift, and if so, reason for applying any new sensor; 4) Whether sensor was moved to another site, and if so, why and whether it was easy to reuse; 5) Effect of adhesive on the patient's skin (damage, etc.); 6) Overall ease of use.

Nurses were told to use the sensors as they would during routine practice. Product literature for both sensor brands was available to the nursing staff and in-services were provided. The extent of instruction was kept to a minimum to most closely mirror normal practice.

After patient data collection was complete a follow-up survey was administered to the nursing staff to investigate their routine practice in the use of disposable sensors and their impressions of the ease of use of the two sensor types.

Sensors Under Test

Nellcor

The Nellcor sensor is constructed with a bandage-type adhesive tape; the components of the sensor are embedded in the plastic tape (Figs. 1, 2). The adhesive is designed to wrap over the tip of the patient's finger. According to the Nellcor sensor Instructions for Use (IFU), "If the sensor is wrapped too tightly or supplemental tape is applied, venous pulsations may lead to inaccurate saturation measurements." Thus, replacement tape should not be used. If the Nellcor sensor adhesive becomes unusable, the sensor should be replaced. Due to the flexible nature of the adhesive bandage-type design, the nurse must pay careful attention to positioning of the emitter and detector.

Figure 1. Nellcor MAX-A OxiMax Adult Oxygen Sensor - Top view.

Figure 2. Nellcor MAX-A OxiMax Adult Oxygen Sensor - Bottom view.

Philips

The Philips sensor is constructed of a soft semi-rigid silicone body that is formed to fit the tip of the finger (Figs. 3, 4). The components of the sensor are embedded in the semi-rigid body. Correct positioning of the Philips sensor is facilitated by the semi-rigid silicone housing which holds the emitter and detector in correct alignment. The Philips sensor comes with an adhesive strip attached to the semi-rigid silicone body. This adhesive strip wraps around the patient's finger to secure the sensor. Additional adhesive strips, which can replace the original strip if it becomes unusable, are provided with the Philips sensors. (Other tape may also be used, per the instructions for use.)

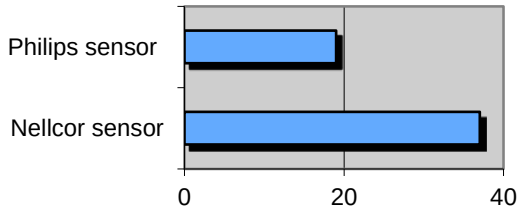
Figure 3. Philips M1131A Adult/Pediatric SpO_2 Sensor - Side view 1.

Figure 4. Philips M1131A Adult/Pediatric SpO_2 Sensor - Side view 2.

RESULTS

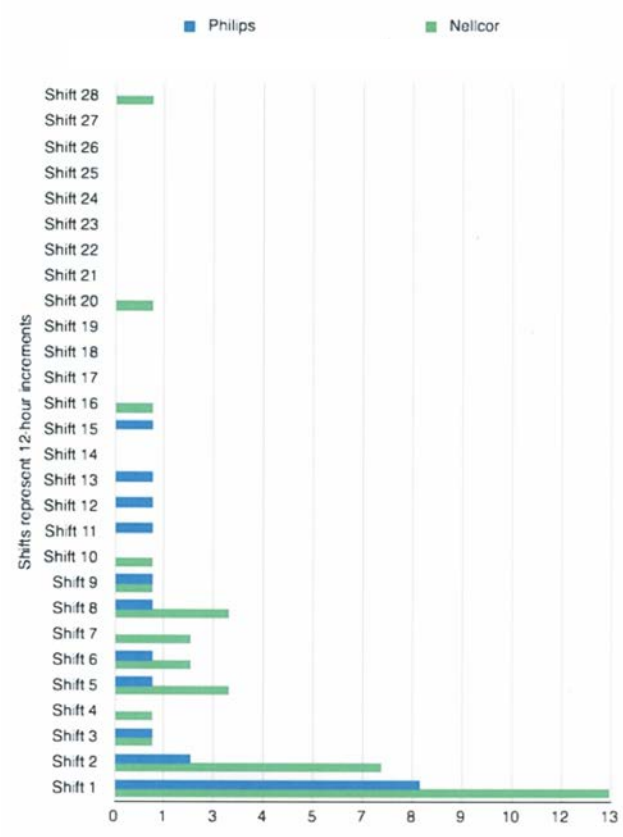
There were 133 patients in the study. Of these, 67 were started with the Philips sensor and 66 were started with the Nellcor sensor. The average patient stay was 3 days, with maximum stay of 15 days and minimum stay of 1 day. The total number of sensors changed was 19 for Philips and 37 for Nellcor (Chart 1).

Chart 1. Number of Sensors Changed



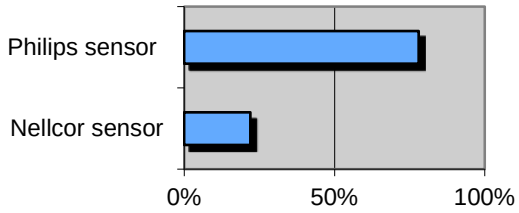
The number of sensors changed per shift for all patients was determined Chart 2). Each shift represents a 12-hour increment. All patients' stays started with shift 1, with the longest patient stay extending through shift 28. For both brands, the most sensor changes occurred during the first two shifts (i.e., 24-hour period). A total of 13 Nellcor and 8 Philips sensors were changed during the first shift, and a total of 7 Nellcor and 2 Philips sensors were changed during the second shift.

Chart 2. Number of Sensors Changed Per Shift



Of the nurses that responded to the post-study survey, 78% preferred the Philips sensor (Comments included that the Philips sensor was “easy to remove and place on another finger” and that it “works best”) and 22% preferred the Nellcor sensor (Chart 3). During normal patient care, 66% of nurses said they would try to retape a sensor rather than replace it with a new sensor. All nurses said that a sensor not sticking affected the quality of the waveform.

Chart 3. **Nurses' Sensor Preference**



DISCUSSION

The two sensors tested represent significantly different designs. The Nellcor sensor components are enclosed in a bandage-type adhesive tape, while the Philips sensor components are enclosed in a semi-rigid silicone body. The primary reason for a sensor change was due to failure of the adhesive (i.e., loss of adhesiveness or wadding of the tape). Therefore, this difference in design may have led to the higher number of Nellcor sensor changes compared to the Philips sensor.

As noted, during normal patient care, 66% of nurses said they would try to retape a sensor rather than replace it with a new sensor. Retaping sensors can decrease the number of new sensors used, and replacement adhesive strips are provided with the Philips sensor. However, the use of replacement tape is contraindicated in the Nellcor sensor IFU.

As previously noted, most sensor changes occurred during the first two shifts. This is primarily because the mean patient stay was 3 days, or approximately 6 shifts. So, there were fewer patients staying the higher number of shifts (i.e., up to shift 28; data was collected for shifts 1 through 28).

Although sensor accuracy was not the focus of this study, previous studies have found that misalignment of pulse oximetry sensors can result in inaccurate readings of 10% or more.[2,3] The semi-rigid silicone body of the Philips sensor promotes correct alignment of the LED and photodetector components, while the bandage-type adhesive material of the Nellcor sensor can be more difficult to position correctly (Figs. 5, 6).

Figure 5. View of the Philips sensor showing the relatively fixed alignment of the LED and photodetector due to the components being molded into a semi-rigid silicone housing.

Figure 6. View of the Nellcor sensor showing misalignment of the LED and photodetector. (Represented by the blue lines, which should be directly opposing each other.)

One factor that could affect proper sensor alignment is long fingernails. The Philips sensor provides approximately 10 mm of space, which can accommodate longer nail lengths (Fig. 6). However, because the Nellcor sensor wraps over the tip of the finger, long fingernails may cause misplacement of the LED and photodetector in a distal direction toward the tip of the finger.

CONCLUSION

The results of this study indicate that the Philips sensor is twice as durable as the Nellcor sensor. The Philips sensor was changed approximately half as many times as the Nellcor sensor. Given the similarity in price between the two sensors, we can conclude that Care Units switching from the Nellcor adhesive sensor to the Philips sensor could save 50% of their expenditure on pulse oximetry sensors.

Furthermore, in the post-study survey that was administered, 78% of the nurses indicated that they preferred the Philips sensor. The main reason given by the nurses was that the Philips sensor was easier to re-use or move to an alternate finger on the patient.

References

1. Mabadeje O, Agwu A, Passaretti K. Do disposable pulse oximeter sensors impact infection rates? A review of the literature. *J Hosp Infect.* 2010 Sep;76(1):93-4. Epub 2010 Jun 9.

2. Barker SJ, Hyatt J, Shah NK, Kao YJ. The effect of sensor malpositioning on pulse oximeter accuracy during hypoxemia. *Anesthesiology*. 1993;79(2):248-54.

3. Guan Z, Baker K, Sandberg WS. Misalignment of disposable pulse oximeter probes results in false saturation readings that influence anesthetic management. *Anesth Analg*. 2009;109(5):1530-3.

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