SCREENING FOR ASPIRATION WITH PULSE OXIMETRY- WHAT DOES THE RESEARCH SAY?

THE QUESTION

Recently, I was involved in an online discussion group with other SLPs and someone proposed utilizing pulse oximetry to determine if a patient may be silently aspirating. I added to the conversation and stated that as I understood it the evidence was equivocal at best. Although, at the time, I couldn't refer to any article off the top of my head that backed up my assertion. No doubt, it would be great if pulse oximetry could tell us if someone might be aspirating in the absence of overt signs. After all, taking a pulse oximetry reading is easy, quick and non-invasive; however, what does the research literature say about this topic?

Is pulse oximetry a reliable method of identifying silent aspiration?

The following is a summary of published research studying pulse oximetry simultaneously with instrumental swallowing assessment (FEES or VFSS) via search of ASHA, PubMed and Google Scholar.

THE RESEARCH

Ramsey, D.J.C., Smithard, D.G. & Kalra, L. (2006). Can pulse oximetry or a bedside swallowing assessment be used to detect aspiration after stroke? Stroke, 37, 2984-2988.

Wang, T-G, Chang, Y-C, Chen, S-Y, & Hsiao, T-Y, (2005). Pulse oximetry does not reliably detect aspiration on videofluoroscopic swallowing study. Archives of Physical Medicine and Rehabilitation, 86(4), 730-734.
"The sensitivity of pulse oximetry for detecting aspi- ration was 39.1% and the specificity was 59.4%. In the entire study sample, 31 patients (51.7%) were accurately identified, using pulse oximetry, as either aspirators or nonaspirators. The positive predictive rate of pulse oximetry in detecting aspira- tion was 37.5%; the negative predictive rate was 61.1%."
CONCLUSION: "Decreased SpO2 exceeding 3% does not indicate aspiration on VFSS. Therefore, the application of pulse oximetry to detect aspiration during regular meals requires further investigation."

Higo, R., Tayama, N., Watanabe, T., & Nito, T. (2003). Pulse oximetry monitoring for the evaluation of swallowing function. European Archives of Otorhinolaryngology, 260, 124-127.
There were a total of 204 subjects in this study divided into one of four groups. Group 1 (control group) consisted of 63 individuals without dysphagia; group 2 were 110 subjects with dysphagia; group 3 included 9 subjects with dysphagia and cuffed tracheostomy tube; finally, group 4 consisted of 22 individuals who had previously undergone laryngectomy. The important and interesting factor with the inclusion of group 4 into this study is that the group 4 subjects cannot aspirate since the airway is surgically separated from the digestive tract. Baseline SpO2

measures were obtained and continuous pulse oximetry readings were taken during videofluoroscopy and for at least one minute following. Readings were taken every 10 seconds. No subjects in group 1 aspirated; however, thirteen members of group 2, and three from group 3 did. Again, no individuals from group 4 aspirated as it is physically impossible. Among aspirators in group 1, eleven of thirteen demonstrated a SpO2 decline of 2% or more. Most subjects had a decline of 2-5% (mean of 4.5%); however, two subjects with Parkinson's showed drops of 14-15%. The other two subjects in group 2 who aspirated showed no decline in SpO2. Additionally, there were three subjects in group 2 who demonstrated SpO2 declines of 7%, 11% and 15% who did not aspirate. The three subjects from group 3 who aspirated demonstrated variable results. One subject showed no change in SpO2, one initially showed an increase immediately after aspirating then followed by a 4% decline and another demonstrated a 7% drop. Most interesting are the results from group 4. Five of the nine laryngectomy subjects exhibited a SpO2 decline of 2% or more (as much as a 9% decline) during videofluoroscopy. Obviously, those declines could not be attributed to aspiration. The experimenters proposed that other factors affect arterial oxygenation levels such as positioning, breath-holding, coughing, compromised pulmonary function and even swallowing itself. This study resulted in the following sensitivity for pulse oximetry as a tool for detecting aspiration: When the cut-off point for significance was set at 4% or greater for SpO2 decline, sensitivity was reported in this study as 46.2% and 84.6% with the cut-off at 2% or more.
CONCLUSION: "In our study, the conclusion is that aspirators practically show an SpO2 decline during swallowing procedures, but that aspiration cannot be predicted or identified by POM [pulse oximetry]."

Colodny, N. (2000). Comparison of dysphagics and nondysphagics on pulse oximetry during oral feeding. Dysphagia, 15, 68-73.
This study included a total of 181 participants which included 104 nursing home residents with dysphagia and 77 healthy, community-dwelling control subjects. Baseline pulse oximetry and pulse rate readings were established across a 10 minute time period for all participants. Pulse oximetry was continued for 10 minutes post swallowing. Dysphagia subjects underwent fiberoptic endoscopic evaluation of swallowing (FEES) and healthy controls were monitored without FEES. SpO2 and heart rate were taken every minute during the experiment. Seventy-two of the 104 dysphagic subjects aspirated and 32 had penetration without aspiration. For all aspirating subjects, the time of aspiration, SpO2 and pulse rates were documented. Those who aspirated on solids, aspirated on liquids, and those who had penetration were compared to the normal group. Results showed that there were significant differences in oxygen saturation between the groups. Oxygen saturation was lowest across before, during and after eating for solid aspirators followed by liquid aspirators then by those who had penetration. Normal participants had the highest mean oxygen saturation levels across times. However, there were no significant within individuals or within group differences. That is, SpO2 did not significant decline during or after swallowing or during aspiration events within any specific subject or within any particular group.
CONCLUSION: "The present findings lend some support to the use of PO [pulse oximetry] as an adjunct to the CES [Clinical Evaluation of Swallow] to discriminate dysphagic from nondysphagic individuals. It does not suggest that PO can be used as a diagnostic tool to assess dysphagia or identify aspiration."

Leder, S.B. (2000). Use of arterial oxygen saturation, heart rate, and blood pressure as indirect objective physiologic markers to predict aspiration. Dysphagia, 15, 201-205.

This study looked at measures of heart rate, blood pressure and SpO2 before, during and after FEES in 60 adult ICU patients. Fifteen of the subjects were not on supplemental O2 and did not aspirate (group 1); fifteen others also not on supplemental O2 did aspirate (group 2); thirty other subjects were on supplemental O2, half aspirated and half did not (groups 3 and 4). Therefore, the 60 subjects fit into one of four groups divided by O2 need and aspiration status. FEES was conducted with 5ml presentations of liquid, puree and solid (cracker). Mean heart rate, blood pressure and SpO2 measures were calculated for all groups for before, during and after FEES. Results showed that there were some heart rate and blood pressure increases during and/or after FEES for all groups. All groups demonstrated a decline in SpO2 during and/or after eating, but the changes were very small. The greatest mean SpO2 change for group 1 was 0.2%, for group 2 was 0.7%, for group 3 was 0.1% and 0.5% for group 4. These changes were not significant. Individually, one subject from group 4 demonstrated an arterial oxygen saturation decline of 4% or more (4.2%).
CONCLUSION: "The presence of aspiration did not significantly change SpO2 values. This was true whether or not supplemental oxygen was required. Therefore, the use of SpO2 as an indirect objective clinical marker of aspiration was not supported by the present data."

Sherman, B., Nisenboum, J.M., Jesberger, B.L., Morrow, C.A. & Jesberger, J.A. (1999). Assessment of dysphagia with the use of pulse oximetry. Dysphagia, 14, 152-156.
Simultaneous videofluoroscopy and pulse oximetry were completed on 46 subjects who were identified as needing instrumental assessment of swallowing following bedside screening. Baseline SpO2 readings were obtained during a one minute minimum sampling period. Pulse oximetry, the presence of penetration or aspiration and whether penetration cleared (spontaneously or cued) or did not clear were monitored. Pulse oximetry readings were collected for 3 minutes following swallowing tasks. Aspiration was observed in 12 subjects while 20 subjects had penetration (with clearance achieved in 10/20). No penetration or aspiration occurred in 14 of the subjects. Baseline SpO2 measures were compared against the lowest SpO2 readings during videofluoroscopy. Among those who aspirated, desaturation ranged between 1% and 12% as a group. Oxygen desaturation ranged from 0-7% for subjects who aspirated and did not clear and 0-8% for those who had penetration that cleared. Subjects that did not have penetration or aspiration had oxygen saturation that ranged from 0-4% According to the authors, their study demonstrated an association between oxygen desaturation and penetration/aspiration as well as a relationship between the severity of dysphagia with the degree of desaturation. The authors speculated that pulse oximetry may be most helpful in identifying patients of low probability of aspirating if they do not exhibit significant desaturation during clinical evaluation. CONCLUSION: The authors concluded that "…bedside pulse oximetry may be a useful tool in the evaluation of patients with dysphagia."

Sellars, C., Dunnett, C., & Carter, R. (1998). A preliminary comparison of videofluoroscopy of swallow and pulse oximetry in the identification of aspiration in dysphagic patients, Dysphagia, 13, 82-86.
In this experiment, pulse oximetry readings of 6 subjects with neurogenic dysphagia were compared to those of 5 healthy subjects without dysphagia. Baseline SpO2 readings and pulse rates were established at 15-second intervals for a total of 5 minutes for the subjects with dysphagia prior to participating in a VFSS. During the VFSS, pulse oximetry readings and pulse rate were taken continuously throughout and for at least 2 minutes following the evaluation. Pulse oximetry and pulse rate baselines were also taken for the normal group. While they did not participate in a VFSS, normal participants were presented with liquids and solids meant to "mimic the VFSS consistencies" and they were monitored for clinical signs/symptoms of

aspiration during SpO2 and pulse rate data collection. Pulse rates did not deviate significantly from normal for participants from either group. Average baseline SpO2 for the dysphagia subjects was 95.3% and 96.9% for the non-dysphagic individuals. Within this experiment, a SpO2 drop of 4% or more indicated a significant change. Of the 6 subjects with dysphagia, 4 of them aspirated; however, only 2 of the 4 demonstrated a significant change in pulse oximetry readings during VFSS. Surprisingly, the subject who aspirated the most during VFSS (>10% of all boluses) did not show any significant SpO2 change.
CONCLUSION: The authors concluded, “The results indicate that there is no clear-cut relationship between changes in arterial oxygenation and aspiration.” Their conclusion makes sense– while pulse oximetry demonstrated change during feeding in two subjects who aspirated, overall this only represents 50% of the aspirators. In consideration of a screening tool, 50% is no better than guessing.

M.J. Collins & A.M.O. Bakheit (1997). Does pulse oximetry reliably detect aspiration in dysphagic patients? Stroke, 28, 1773-1775.
Fifty-four stroke patients (28 male, 26 female) who were referred for videofluoroscopic swallow exam were studied with simultaneous pulse oximetry and VFSS. Baseline SpO2 was established prior to the testing procedure. Subjects swallowed 150mL liquid, 3oz puree and 1″ sized piece of cookie during the testing. Pulse oximetry readings were taken at the time of swallow/aspiration, 2 minutes after (lowest reading was recorded) and 10 minutes after VFSS. In this study, the authors considered 2% or more decline as significant. Thirteen of the male subjects aspirated and nine of the females did. When comparing mean baseline arterial oxygen saturation to measures at 2 minutes after (remember, lowest reading was taken), males showed a SpO2 decline of >2% (3.1%), while females showed a drop of 1.6%. The experimenters also found that subjects less than 65 years of age demonstrated a greater SpO2 decline, especially among males. Therefore, they concluded that pulse oximetry had higher predictive value in males <65 years.
CONCLUSION: “Pulse oximetry is a reliable method of diagnosis of aspiration in most dysphagic patients. However, careful interpretation of pulse oximetry data is necessary in older subjects, possibly those with chronic pulmonary disease, and smokers.”

Colebatch B.J. & Halmagyi D.F. (1962). Reflex airway reaction to fluid aspiration. Journal of Applied Physiology, 17, 787-94.
Hirst, L. J., Ford, G. A., Gibson, G. J., & Wilson, J. A. (2002). Swallow-induced alterations in breathing in normal older people. Dysphagia, 17, 152-161.

See also:
Colodny, N. (2004). Pulse oximetry as an indicator for aspiration: The state of the art. Perspectives on Swallowing and Swallowing Disorders (Dysphagia), 13, 9-13.
Ramsey, D., Smithard, D. & Kalra, L. (2005). Silent aspiration: What do we know? Dysphagia, 20, 218-225.
Ramsey, D., Smithard, D.G. & Kalra, L. (2003). Early assessments of dysphagia and aspiration risk in acute stroke patients. Stroke, 34, 1252-1257.