Calculated oxygen transmissibility through various piggyback contact lens systems

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Purpose
To calculate values of oxygen transmissibility of piggyback (PB) systems by applying the concept of resistors in series,1 and to create a color-coded spreadsheet to help the practitioner to choose a combination of soft and rigid lenses that provides enough oxygen to the cornea.

Method
Theoretical calculations were used to predict the oxygen transmissibility of PB systems, considering all FDA materials, for both soft and rigid gas permeable (RGP) lenses.2 Different lens powers were taken into account.3 The Holden-Mertz (HM) Dk/t criterion of 24 Fatt units4 and the Harvitt-Bonanno (HB) criterion of 35 Fatt units5 were used as reference points. The harmonic average thickness6 was used when calculating oxygen transmission through the two lenses of the PB system. The oxygen transmission of a piggyback system was calculated using Ohm’s law. The resistance of the two lenses in series was calculated as the sum of the resistance offered by each. Transmissibility is the reciprocal of resistance.

Results
The combinations of 42 RGP and 36 soft materials were used for calculation, using a computer software spreadsheet. A summary table was created and a colour code was introduced to easily show if the PB system satisfies both HB and HM criteria (green), only HM criterion (yellow), or neither of them (red). This table represents the Dk/t of a PB system where the harmonic average thickness is 0.09 mm for the soft lens (valid for lenses ranging from −0.75 to +3.00 D, with an error <5%), and 0.20 mm for the RGP lens. As we can see, several combinations are available that can ensure an appropriate level of security in PB fitting. Nevertheless, hydrogel soft contact lenses should be used only if their Dk is greater than 25 units and they are combined with hyper-gas permeable RGP lenses (Dk>140). If the RGP lens Dk is 100, only hydrogel materials with Dk>30 should be used. Silicone-hydrogel soft contact lenses offer a larger choice of combinations, but the Dk of the RGP lens should not be less than 56 units. Different tables can be calculated varying the thickness and the power of both RGP and soft contact lenses. A free Excel calculator is available from the corresponding author.

Conclusions
Along with traditional RGP lenses there are several proprietary designs for irregular and aberrated corneas. Despite providing excellent vision and oxygen transmissibility, patients may be unable to tolerate rigid lenses or achieve their desired wearing schedules even when the lenses are fitting well. In these cases, piggyback may be considered. The idea of piggyback contact lens system is not new, nevertheless in the past, hypoxia reaction in compromised cornea was the major concern.7 Now, the available hyper oxygen transmissible lens materials make these dual-lens systems a viable option for the compromised cornea.

References