Extended Release of DMPC from Silicone Hydrogel Contact Lenses

W.G. Pitt¹, Y. Zhao¹, K.X. Perez¹, D.R. Jack¹, J.L. Nelson², and J.D. Pruitt³

¹Brigham Young University, Provo, UT, 84602, USA; ²Alcon, Johns Creek, GA, 30097, USA

pitt@byu.edu

ABSTRACT SUMMARY
Characterization of the release of phospholipids from a silicone hydrogel contact lens over 30 days was performed to assess the possible use of these lenses for phospholipid delivery to increase comfort to patients.

Contact lenses were loaded with 200 µg of radiolabeled 1,2-dimyristoyl-sn-glycero-3-phosphatidyl choline (DMPC) from a solution of n-propanol. To simulate 30 days of daily use with overnight cleaning, these lenses were eluted for 16 at 35°C into ATF, and then eluted at room temperature (~22°C) for 8 hrs in 1 of 3 commercial contact lens cleaning systems. This was repeated for 30 days.

The elution of DMPC into ATF showed a burst effect on the first day, followed by a fairly constant amount of elution through the remaining days. The type of cleaning system had a statistically significant effect on the elution rate during exposure to ATF. The rate of elution into cleaning solution showed a slight burst effect on the first day, followed by fairly constant elution, with one cleaner producing significantly more elution.

INTRODUCTION
Previously our research group has examined the incorporation of DMPC in single use daily wear silicone hydrogel contact lenses. (1) We have shown that the lenses can be easily loaded and that delivery of the DMPC to artificial tears in vitro is apparently governed by diffusion of phospholipids from the lens. (2) Those previous studies only examined 72 hrs of delivery in lenses that were designed for single use daily wear. About 1 µg of DMPC was delivered from those lenses during the first 10 hours of simulated wear.

The objective of this study was to determine if sustained released of DMPC could be observed from a lens for 30 days of simulated daily wear.

EXPERIMENTAL METHODS
Lenses. Experimental lenses in pure water in blister packs were obtained from Alcon (Johns Creek, GA).

Loading. Lenses were blotted dry and loaded by soaking for 85 s in 0.9% (w/v) solution of ¹⁴C-labeled DMPC in n-propanol at room temp as detailed previously to load 200 µg DMPC per lens. (1) Then lenses were rinsed 2X in distilled deionized water (ddH₂O) and stored in ddH₂O for < 20 minutes before the subsequent elution.

Elution. To simulate daily wear, 4 lenses were placed in 3 mL of artificial tear fluid (ATF) and slowly swirled on an orbital shaker at 35°C.

The lenses were eluted in a simulation of daily wear followed by nightly cleaning for 30 days as follows. The lenses were placed in ATF solution at 35°C with shaking for 16 hrs daily. The solution was sampled for DMPC at the end of each 16-hr period. Each lens was rinsed and transferred to one of 3 cleaning solutions for 8 hrs at room temperature (~22°C), without shaking. The lens care solutions tested were ReNu MultiPlus® NoRub, ALCON® OPT1-FREE® RepleniSH® multi-purpose disinfection solution, and ALCON® Clear Care®. The solution was sampled to measure eluted DMPC at the end of each 8-hr period.

To examine the effect of each cleaning solution, some lenses were eluted in cleaning solution for 72 hrs. Clarity. The clarity of the lenses was quantified as the light transmission at 610 nm.

RESULTS AND DISCUSSION
The clarity of the lenses was not significantly decreased by loading 200 µg per lens.

Figure 1 shows the daily elution of DMPC into ATF during each 16-hr interval. There was a burst observed on the first day, but subsequent days showed fairly constant DMPC release through the completion of the study. During the first 2 weeks the average elution was about 2 µg/day. At the end of 30 days, elution exceeded 1 µg/day. Elution was greatest from lenses cleaned in RepleniSH.

![Figure 1](image1.png)

Figure 1. Elution of DMPC into ATF in each 16-hr period. The colors indicate the various care solutions that the lenses were stored in “overnight” for 8 hrs. Data show mean and standard deviation, n=4.

Figure 2 shows the daily elution of DMPC into each cleaning solution at 22°C during each 8-hr interval. There is little if any burst observed. Daily elution was greatest from lenses cleaned in RepleniSH and decreased during the first 3 weeks. Elutions into ReNu and Clear Care were almost an order of magnitude less than into RepleniSH, and were not significantly different from each other.
Figure 3 shows the cumulative elution from each set of lenses over the 30-day period. Cumulative release of DMPC from lenses cleaned in RepleniSH is much greater than the other two data sets. The cumulative release from lenses cleaned in Clear Care was slightly greater than lenses cleaned in ReNu, even though elution in Clear Care cleaning solution was less than in the other cleaners.

Elution studies for 72 hrs were done in each of the cleaning solutions and in ATF to examine if RepleniSH cleaner promotes elution more than the other fluids. The results show that this is the case (data not shown).

There may be some component of the RepleniSH system that interacts with the silicone hydrogel chemistry or with the DMPC to promote elution from the lens. Such a component is not necessarily a negative. Even though more than half of the DMPC was eluted from the lenses cleaned in RepleniSH, the daily elution rate did not slow down significantly toward the end of the 30-day period. This component apparently interacts with the silicone hydrogel polymer. This component’s influence is observed even after RepleniSH is removed and the elution occurs in ATF, suggesting that it interacts with the silicone polymer. The listed components of RepleniSH that are not in common with the components of ReNu and Clear Care are: sodium citrate, propylene glycol, Tetronic® 1304, nonanoyl ethylenediaminetriacetic acid, polyquaternium-1, and myristamidopropyl dimethylamine. Further experiments are ongoing to determine the mechanism of enhanced DMPC release from silicone hydrogel contact lenses.

CONCLUSION
Silicone hydrogel contact lenses can be easily loaded with 200 µg of DMPC without compromising their clarity. Elution of the DMPC into ATF occurs at rates greater than 1 µg per day, and this rate is sustained for at least 30 days. Elution into any of the care solutions is slower than into ATF. Elution into RepleniSH care solution is significantly greater than into the other care solutions. Exposure to RepleniSH during the 8 hrs of simulated cleaning also enhanced the elution from the same lenses when placed in ATF for simulated wear.

This silicone hydrogel contact lens has potential to store and release DMPC over an extended period of daily wear. This could be very beneficial to wearers who experience eye discomfort associated with a lack of phospholipid.

REFERENCES

ACKNOWLEDGMENTS and DISCLOSURE
This research was supported by financial support and materials from Alcon Corporation. Two of the authors are employees of Alcon, and none of the authors has any direct financial interest in commercial products from this research.