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2 **Solution for dead space problem in ranibizumab syringe**
3 **system**

4 **ABSTRACT**

5 Abstract

6 These are drugs that inhibit the actions of vascular endothelial growth factor, which requires a high economic burden for the health systems. We evaluated the amount of fluid retained in two different types of syringes with billed and non - billed rubber stopper. Difference between two syringes is 0.037 g. This indicates that a significant amount of volume loss is due to dead space between syringe and needle. Consequently, design of rubber stopper of the plunger as billed form, will reduce significant amount of drug loss due to dead space volume.

7 Key words: Anti-vascular endothelial growth factor, dead space volume

8 **1. INTRODUCTION**

9 Intravitreal injections of vascular endothelial growth factor (VEGF) drugs for neovascular age-related macular degeneration (AMD) is the current preferred treatment modality, which requires a high economic burden for the health systems. On average each patient receives monthly injected, at least 6 anti-VEGF injections in a one year period, mainly ranibizumab 0.5 mg in volume of 0.05mL. If this treatment regimen can be applied successfully, the choroidal neovascular membrane usually stabilizes and generally regresses leaving a satisfactory visual acuity.

10 The commercial presentation of Lucentis is a 3 ml vial with a chlorobutyl rubber stopper containing 0.23 ml of ranibizumab; a blunt 18-gauge filter needle and a 30-gauge injection needle are also included in the package (http://www.novartis.com.au/PI_PDF/luc.pdf). All the system is presented in a single closed package, to provide 0.05 mL of 10 mg/mL solution for intravitreal injection. The drawback of this system is that syringe system has dead space and is not pre-filled for this reason the surgeon should withdraw all the liquid from the vial into a tuberculin syringe through a 18-gauge filter needle to obtain the desired injection volume and then insert a 30-gauge needle for intravitreal injection. All through this process we experience a great amount of drug volume sequestered at the dead spaces of both syringe and needle hubs (Figure 1).



Figure 1. We can see the drug volume sequestered due to dead spaces after injection of ranibizumab (Lucentis®).

2. MATERIAL AND METHODS

We evaluated the amount of fluid retained in two different types of syringes following injection (Figure 2). Firstly, ten syringes with non- billed rubber stopper of Lucentis and 10 syringes with billed rubber stopper of 1ml tuberculine were weighed in a high precision bascule. In a second phase we filled the syringes with distilled water, removed air bubbles then pushed the syringe piston to the end. Afterwards, the needles were immediately weighed again.



Figure 2. A: Two different types of syringes: syringes with non - billed rubber stopper B: Syringes with billed rubber stopper.

2.1 Data Analysis

Statistical analyses were performed using the Mann-Whitney U test. A p-value of less than 0.05 was considered to show a statistically significant result.

3. RESULTS AND DISCUSSION

Mean weight of syringes with billed and non - billed rubber stopper was 2.3264 ± 0.00823 and 2.4067 ± 0.0084 g, respectively. Following injection, mean weight of the experiment syringes with billed or non- billed rubber stopper was 2.3838 ± 0.0134 and 2.5011 ± 0.0063 , respectively. Volume of dead space was 0.0944 g for syringe with non- billed rubber stopper and 0.0574 g for syringe with billed rubber stopper ($p=0.001$).

Wolf et al.¹ indicated that an extra volume of 0.137 ml is required to obtain 0.05 ml of medicine. Ribeiro et al.² reported a volume loss of 0.05 ml from aspiration needle. Montero et al.³ reported that residual amount of drug due to dead space in needle with 30 and 18 gauge was 0.051 g ($51\mu\text{l}=0.0051\text{ml}$) and 0.073 g ($73\mu\text{l}=0.0073\text{ml}$), respectively. We showed that difference between two syringes was 0.037 g. This indicates that a significant amount of volume loss is

due to dead space between syringe and needle. An extra volume of 0.137 ml is required to obtain 0.05 ml of medicine for using syringe with non-billed rubber stopper while 0.100 ml extra volume is required for using syringe with billed rubber stopper. If pre-filled syringe system with billed rubber stopper is used only 0,014 ml extra volume is required to obtain 0.05 ml of medicine.

4. CONCLUSION

Consequently, loss of drug during injection of ranibizumab (Lucentis®) leads to increased economic loss. Design of pre-filled syringe system with billed rubber stopper will reduce significant amount of drug loss due to dead space volume. Also prevention of dead space lost may help to reduce cost of the drug.

References:

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