INTRODUCTION

The pharmaceutical industry is moving from vials to prefilled syringes for injectable drugs. Indeed prefilled syringes offer several advantages over vials, such as better dose accuracy, ease of use allowing patients to self-inject prescribed medications at home and increased safety. In addition to that they do not require drug overfilling (up to 25% for vials).

Needlestick injuries which expose healthcare workers to bloodborne pathogens (Hepatitis B and C, HIV viruses,...) remain a main concern. Safety devices that can be attached to standard prefilled syringes have been developed to reduce needle exposure. They are classified into two categories: passive if they automatically shield the needle without user intervention and active if they need to be activated manually when the injection is complete.

Nemera has developed a platform of passive safety devices, Safe’n’Sound® (Figure 1), that was also designed to deliver a consistent and accurate dose thanks to a patented mechanism. Design optimization for these output parameters is key for the pharmaceutical companies as they have an impact on the treatment efficiency and drug overfilling.

BACKGROUND

The safety feature of marketed passive safety devices is based on the same concept: when the head of the plunger rod reaches the position corresponding to the theoretical end of the injection, a spring is released and the needle is instantaneously covered by a sheath.
In reality, activation is designed to be triggered just before the theoretical end of the injection to ensure activation will happen despite high tolerances on the height of the syringe glass barrel. The user has limited control on the activation. That is the main advantage of these products. However if the activation trigger is not well adjusted, a limited volume of drug may not be injected.

**EVALUATION OBJECTIVE**
The objective is to compare the non-injected volume from 1ml prefilled syringes equipped with three passive safety devices after the simulated injection by healthcare professionals and non-healthcare professionals.

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Three registered nurses and seven non-healthcare professionals were involved in the study. They performed 6 injections simulated in a silicon pad (Figure 2) for each three devices equipped with 1ml prefilled syringe from the same batch filled with 0.5ml of distilled water and a stopper from the same batch. To reach these conditions marketed devices were disassembled from the syringe containing the marketed drug and mounted with a new syringe and with a new stopper screwed on their specific plunger rod. So, the only difference between the three systems including the syringe, the stopper, the liquid to be injected and the safety device was the safety device. Injection force was the same for the three systems due to the use of identical syringes, stoppers and liquid. Safe’n’Sound® device was used in the system referenced as Safe’n’Sound® System. The other marketed devices are referenced as Device A and Device B which were used with System A and System B respectively.

The tests were performed according to Nemera internal protocol P084-02 [1]. The main steps were:

1) Assembly of the empty syringe with the device
2) Stopper screwing on the device specific plunger rod
3) Plunger rod insertion (syringe temporarily uncapped)
4) System weighting without syringe needle shield (mass1)
5) Syringe filling with 0.5ml of distilled water by suction
6) System weighting (mass2)

The non-injected volume is defined the difference between the weight after injection and the weight of the empty system (mass2 – mass1).

**RESULTS**
180 injections were performed. Bias was minimized by selecting a sufficient number of evaluators each used a large enough sample of systems (18).
As shown in Figure 3, average and variability of the non-injected volume were very different between systems and significantly lower for the Safe’n’Sound® System than that for the two comparators. For system A, 3 values on 180 of the residual volume were larger than 50μl, representing 10% of the filled volume.

**DISCUSSION**

The safety device design clearly impacts the amount of residual fluid in the syringe after use. The better performances of the Safe’n’Sound® can be explained by the following reasons:

1. Just before the end of injection, a low additional force applied by the user on the plunger activates the safety feature. This additional force is not felt by the user who continues to push on the plunger to complete the injection. A spring is then released which pulls the syringe back, while the user finger is still pushing on the plunger. These two opposite forces help emptying the syringe (Figure 4). This patented mechanism compensates the advance release of the safety feature that happens on the three passive devices. If the additional force is too high so that the user can feel it, it can give him the false perception that the injection is completed and make him stop pushing on the plunger. In some cases the spring can be located at the syringe tip and prevent the user from checking the completeness of the injection. The adjustment of this additional force is critical for safety devices. That is why it has been validated by a user test on the Safe’n’Sound® [2].
2. In addition to this mechanism, the Safe’n'Sound® features improved ergonomics compared to other devices so that users can push smoothly and continuously on the plunger until the end of the injection. It increases the precision of the injection. Users can activate the device in a very convenient and repeatable way. Safe’n'Sound® is less user dependant than the two other safety devices. This advantage is becoming critical for non professional people.

3. Nurses agree that Safe’n'Sound® doesn't modify the standard injection process [2].

CONCLUSION

This study shows that using Safe’n'Sound® allows to deliver a more complete and consistent drug dose compared to other commercially available passive safety devices. It reduces the costs attributed to drug overfill volume and increases treatment compliance.

Good performances of Safe’n'Sound® over competitive devices are the result of a design fine tuning process based on a system approach. Safe’n’Sound® tolerances have been specified according to the dimension variability of marketed syringes and stoppers.

Tests [3] performed also highlighted much better results in terms of injected volume for a syringe equipped with the Safe’n’Sound® device than for a naked syringe. Thanks to the Safe’n’Sound® specific safety feature activation mechanism the variability attributed to human error is reduced.

REFERENCES

[1] Nemera internal test protocol P084-02 (Safe’n’Sound® 1 ml long staked and luer lock –non injected volume)
[2] Biomatech study report 77291 (Simulated clinical use testing on a passive safety device for prefilled syringes)
[3] Nemera internal test result report TRR_01006-908853