INTRODUCTION

Historically, injectable drugs are contained in vials and administered in healthcare facilities by professionals. But with an increasing trend towards self-administration and at-home administration, prefilled syringes (PFS) has emerged in the early 2000’s. The growing popularity of PFS is due to its ease of use, facilitating the injection process and reducing the total injections steps, but also the improved user safety and the reduction of dosage errors. It is also linked to their cost efficient profile not requiring drug as much overfilling as vials (up to 25% for vials).

In the parenteral industry, needlestick injuries remain a global concern. According to the World Health Organization, over 3 million exposures to blood occur every year, resulting in health, psychological and cost issues. Safety devices for prefilled syringes have been developed to aid in the protection of users from needlestick injuries. Safety devices are classified in two categories: passive if the safety feature automatically activates at the end of the injection without any additional gesture from the user; active if the user needs to perform an additional gesture to trigger the safety feature once the injection completed.

Nemera has developed Safe’n’Sound® (figure 1), a platform of passive safety device for prefilled syringes which not only aid in the protection from accidental needlestick injuries, but was also designed to optimize drug dose delivery (consistency of drug dosing) thanks to a patented mechanism. Design optimization of these output parameters is key for pharmaceutical companies as they have an impact on treatment efficiency and drug overfilling.
BACKGROUND
Marketed passive safety devices have based their safety feature mechanism on the same kind of concept: when the head of the plunger rod reaches the position corresponding to the theoretical end of the injection, a spring is released covering the needle with a sheath. In reality, safety feature activation is designed to be triggered just before the theoretical end of the injection to ensure activation. The main advantages of passive safety device is the limited control the user has on the activation. 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 between three marketed passive safety devices for 1ml PFS after simulated injection performed by non-healthcare and healthcare professionals.

MATERIAL AND METHOD
Three registered nurses and seven non-healthcare professionals were involved in the study. Each user performed 6 injections on a silicone pad (figure 2) with each of the three passive safety device. Safety devices were equipped with 1ml prefilled syringes and stopper from the same batch, and filled with 0.5ml of distilled water. To reach those conditions, marketed safety devices were disassembled from the syringes containing the marketed drug, and mounted with the new syringe and stopper mentioned previously. The specific plunger rod of each device was screwed back in the new stopper. As a result, the only difference between the three systems including the syringe, the stopper, the distilled water and the safety device was the safety device. As syringes, stopper and liquid used were the same, injection force was similar between the systems. Safe’n’Sound® device is referenced as Safe’n’Sound® System. The two other marketed devices A and B are respectively referenced as System A and System B.

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 as 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 using a large enough number of systems (18).

As shown in Figure 3, average and variability of the non-injected volume were very different between the systems. Safe’n’Sound® system demonstrated better results than the two comparators, with significantly lower values for both parameters. The average non-injected volume of system A and B were respectively 3 and 1.5 times higher than the Safe’n’Sound® one. Moreover, 3 residual volume values out of the 60 for System A were larger than 50µl, representing 10% of the filled volume.

DISCUSSION

The study highlights how safety device design impacts non-injected volume. Improved performances of Safe’n’Sound® system can be explained for the following reasons:

1. Just before the end of injection, an extra force is applied by the user which activates the safety feature. As a passive safety device, this extra force is not felt by the user who continues to push on the plunger rod to complete the injection. A spring is then released pulling the syringe back, while the user thumb is still pushing on the plunger rod. These two opposites forces applied by the user and the spring during the injection process help emptying the syringe (Figure 4). This patented mechanism compensates the advanced release of the safety feature which happens on the three marketed passive safety device. It is critical not to have an additional force too high (the user can felt) as it could misunderstood him and give him the false perception that the injection is completed. If so, the user could stop pushing on the plunger, resulting in higher non-injected volume or non device activation. The adjustment of this additional force being critical for safety devices, it has been validated through simulated user studies for Safe’n’Sound® [2].
2. In addition to its mechanism, Safe’n’Sound® has also been designed to ease the use. Through several design features, Safe’n’Sound® improves the ergonomics for the user, allowing them to push smoothly and continuously on the plunger rod until the end of the injection. It results in an improved precision of injection. With Safe’n’Sound®, users can activate the device in a very convenient and repeatable way, making it less user dependent than other marketed safety device. This advantage is even more critical for non-professional users.

3. Moreover, contrary to other passive safety device, Safe’n’Sound® spring is located at the syringe flange allowing clear visibility of the tip and inspection of the drug prior during and after injection. As a result, if necessary the user can check if all the drug has been delivered prior removing the pressure on its thumb.

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

CONCLUSION

This study highlights how Safe’n’Sound® optimizes drug dose delivery, minimizing the non-injected volume (lower average and variability) compared to other commercially available passive safety device. It results in increased treatment compliance and cost savings for the pharmaceutical companies, reducing the need of overfilling. Other tests [3] have also highlighted how Safe’n’Sound® guarantees a non-injected volume at least as low a naked syringe. Good performances of Safe’n’Sound® are linked to its functioning which reduces human error.

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