Research on the Design of Recycling Medical Needle Safety Bayonet-Lock Box

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Abstract. In order to avoid contaminations and spread of diseases in the use of needles, hospitals adapted disposable policy after one single used. Needles should be used only once and must be disposed of for recycling to avoid infections and spread of diseases. Also to avoid any poking accidents to the medical staffs and recycling personnel in the process of collection, it was accustom to put the needle head back to the needle case, but because the hole of the needle case is small, medical personnel could be by accident or carelessness poke the needle to his or her own hand. This design proposes an innovative collection box for the needle of syringe recycle under safety and management consideration. It can effectively recycle needles in real time and record the time of using needles. It can avoid people repeated use of drugs at home that is a mentally disabled. It is not only simple in structure and low costs, but also easy to operation. It can avoid puncturing the medical personnel and personnel who recycle medical waste. This collection box is composed of a box body and a box cover. On the box cover, it contains one or more needle recycle holes. The needle can be plugged on the needle recycle hole. And the hole has a large circular portion of the fixed ring. Furthermore, the top end with several Bumps structure called Fixing pin fork can restrict the needle to avoid detachment on the inner side of in the upper diameter hole. Therefore, plugging the needle into the box cover and using Fixing pin fork at in the upper diameter hole can separate the needle and syringe. After that, the used needle and syringe can be stored inside the collection box. In this design, it demonstrates a simple structure with a low production cost. Moreover, it is very convenient for people usage.

Keywords. Medical needle recycling, safe needle collection box, safety protection, hypodermic needles.

1. Introduction

Some chronic patients are treated at home. They need to inject on time in the home or other places. But some of them do not care about it or forget to inject with some reasons, maybe will cause to forget or repeat to inject. It is harmful to the treatment of patients. More seriously, it will aggravate state of illness. Taking diabetes as an example, more than 110 million people with diabetes in china, about 30% of them
need to monitor blood sugar and inject insulin. On average, each patient who needs to inject insulin uses disposable injection instruments twice to three times a day. This means that there are 60 to 90 disposable injection needles discarded every month. Many people use the way to put on a needle cap and then throw it into the garbage bin at home. But there are certain safety risks. Because the needle cap is easy to fall off, when the cleaning personnel collect or transport garbage, they are likely to be punctured by the needles.

The proper disposal method is to place the used needle in a special sharps container for disposal to avoid contamination [1]. In recent years, no matter in our country and abroad, there had been a number of injuries caused by discarded medical needles. The root cause is that we didn’t do a good job in medical needle recycling. According to Aberdeen Journals Ltd 2019 reported, hypodermic needles have stabbed five employees this year at the Waste Management Recycling Brevard plant — sending them to the emergency room for blood-borne pathogen treatments [2]. According to DCT Passport reported, a worker of a recycling center in Lossiemouth pricked his finger on a needle pulled from a bag of rubbish. He was taken to accident and emergency where blood tests were taken. Fortunately the results came back clear [3]. Hypodermic needles have no place in a recycling bin, said Amy Boyson, Waste Management community affairs manager. Waste Management Recycling Brevard processes 350 to 400 tons of materials per day at the Coca facility. Items entering the plant travel on a conveyor belt past six employees working the “pre-sort line”. Working quickly with both hands, these employees look for non-recyclable items, then grab them and toss them into various [4]. It is difficult to recycle medical needles. And the process of recycling is very inconvenient. Since 2017, Portland has handed out more than a half million free needles. At the same time, Portland has made significant efforts to keep its streets, parks and playgrounds free of used syringes. We can more than a dozen community needle collection boxes placed all over the city. Public works collects them off the ground when reported [5]. The medical personnel may be injured accidentally during recycling. It is likely to cause infection and the problem has not a good solution. Generally, the hypodermic needles will be discarded after using. Some Medical waste will be collected by specialized Medical recovered vehicle. The others will be burned, still others will be landfilled. But the process of recycling is hard to regulation. Although the government has already formulated policies, there are still defects in recycling. For Example, the Philadelphia Public Health Department installed seven of the safe syringe disposal bins at SEPTA stops and public parks throughout the Kensington neighborhood where Mayor Jim Kenney declared a ‘disaster’ earlier t [6]. That is why we can see hypodermic needles during a walk on public places.

Used cotton wool and syringes with traces of blood are not an unusual sight on the banks of Kiberege springs in Baringo County. Some of the children pick the used syringes, fill them with water and play nurse; pretending to “inject” each other or imaginary patients [7]. Shaniara Akram, the Australian-born wife of famed Pakistani cricketer Wasim Akram, took to Twitter to report seeing “4 dozen open syringes” during a walk on the beach [8]. A local resident of Thurston County neighborhood said, she spent only an afternoon picking up a bigger needle storage bucket [9]. Because medical institution did not comply with medical waste disposal rules, the Medical waste will be recycled secretly by corrupt businessmen.

The advantages of this study are to better understand the injection conditions to effectively increase their usability. Example: If you are a diabetic, you must inject insulin at home, but you still need help or help because of difficulty in exercising. And if it is Alzheimer’s disease, the patient can prevent repeated injections, please put a green label on top. And Child contact must be avoided to cause any dangerous contact.

2. Theory Process

2.1. Traditional Methods

As shown in figure 1, there are some potential problems with traditional needle recycling box.
There are three types of needle recycling on the market:

(1) Traditional collection is common in small clinics and families. They just throw the waste into the garbage bin without garbage classification.

(2) Resin barrier design, the special design is syringe with resin barrier. In case avoid any poking accidents to medical personnel, and accustom to put the resin needle head back to the needle case after injecting.

(3) Syringe collection box, the device is the latest design. It can separate the needle from the syringe. But the design is not advanced in material or technology.

2.2. Design Principle

This collection box is composed of a box body and a box cover. On the box cover, it contains one or more needle recycle holes. The needle can be plugged on the needle recycle hole. And the hole has a large circular portion of the fixed ring, as shown in figure 2.

Furthermore, the top end with several Bumps structure called Fixing pin fork can restrict the needle to avoid detachment on the inner side of in the upper diameter hole. Therefore, plugging the needle into the box cover and using Fixing pin fork at in the upper diameter hole can separate the needle and syringe.
After that, the used needle and syringe can be stored inside the collection box. In this design, it demonstrates a simple structure with a low production cost. Moreover, it is very convenient for people usage.

The advantages of this design are listed as follows:
(1) Furthermore, we can better know the condition of injection, to effectively promote its usability. (Example 1: If the diabetic, must inject the insulin when at home, but because the patient still need help or assistance due to difficulty in movement.)
   (Example 2: In case of Alzheimer, patient can prevent repeat injections, indicate green label on top.)
   (Example 3: Must avoid children to come in contact that might cause any danger.)
(2) In special case with infectious patient, injury can be prevented in the accidental poke to medical personnel and environmental protection personnel.
(3) Because the structure is simple and it is easy to carry, it can be used in hospitals, clinics and at home.

3. Results and Discussion

3.1. Structural Design and Installation
As shown in figure 3, this structure is for the design of needle separator. The box covers contains many needle recycle holes. Plugging the needle into the box cover and using Fixing pin fork at in the upper diameter hole can separate the needle and syringe. After that, the used needle can be stored inside the collection box.

The actual use of finished products is shown in figures 4 and 5. The needle and syringe are separating, and the used needle is stored inside the collection box.

![Figure 3. The design of structure.](image)

![Figure 4. The sample of design.](image)
3.2. Optical Microscope

The morphology of the needle was observed by Optical Microscope 40X (OM), as shown in figure 6, there is an oblique section on the tip of the needle. That is why need more protective measure. Although the thickness and length of the needle under structure is different, it is suitable for our design collection box.

3.3. X-ray

As shown in figure 7, the morphology of the needle in the collection box was observed by X-ray (60 KV, 1MA, <20μ gy/h). We pay more attention to the tip of the needle with solid line circle. The design of collection box in protective condition is circled by the dotted line. This collection box is designed with Fixing pin fork is not easy to fall off make the medical waste recycling process easier and safer.
4. Conclusion
The usage of needles is very wide, not only in hospitals and clinics but also chronic patients at home which needed the use of needles. How to collect the needles after used to avoid danger and other problems. This is what we must put attention to. This design aim at how to use safer, more convenient and environmental recycling. Most importantly, avoiding the secondary puncture risk from the source is our direction.

(1) Furthermore, we can better know the condition of injection, to effectively promote its usability.
(2) Injury can be prevented in the accidental poke to medical personnel and environmental protection personnel.
(3) Because the structure is simple and it is easy to carry, it can be used in hospitals, clinics and at home.
(4) It can reduce the patients are worried about the safety of the needles.

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