

# The Development of a Digital Mobile Infusion Bag: An Instrument for Preventing Occlusion of Intravenous Infusion

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## Abstract:-

**Aim:** This study aimed to develop a Digital Mobile Infusion Bag, an instrument for preventing the occlusion of intravenous infusion while mobilization. It replaces infusion stand when patients using intravenous infusion want to mobilize. **Methods:** This quantitative study started from developing the instrument and followed by testing the instrument. At this stage, the authors developed the instrument. **Results:** A Digital Mobile Infusion Bag has been developed. It was made of materials that are strong enough to withstand a 500 ml plastic infusion bottle. This instrument ensures the safety and comfort of the patients with intravenous infusion during mobilization and prevents occlusion. The bag is equipped with belts that hang around the adult patient's shoulder and upper arm so that the infusion bottle will not come off. In addition, the infusion bottle is also covered with a lock to make it upright. The instrument also has a balloon covering the infusion bottle to provide controlled pressure for pushing the infusion fluid to keep it flowing. The pressure is given to the balloon based on the Mean Arterial Pressure of the users. **Conclusion:** The instrument has been developed to prevent occlusion of the intravenous infusion when the patients with intravenous infusion performing physical movement activities such as walking, standing, or going to the bathroom. Instrument Testing is needed to prove the effectiveness of the instrument in preventing the occlusion when the users of it perform mobilization.

**Keywords:** *Infusion, Occlusion, Intravenous, Mobilization.*

## I. INTRODUCTION

Infusion is a process of inserting fluid into a vein using an infusion catheter which is often performed on patients receiving hospital treatment or other health care advice. Intravenous infusion or IV therapy is used to help health professionals insert fluids into the blood vessels for patients who are dehydrated, unconscious, or unable to swallow. It serves several functions: as a means of injecting nutrients or electrolytes to recover acid-base balance disorders of the body, as a means of blood transfusion, and as a way of administering drugs into the body (1). Intravenous medication is essential for many hospital inpatients. There

are many patients using intravenous (IV) infusions in hospitals. The use of IV infusion is not only in hospitals but also in other health care settings such as public health centers, nursing homes, or home care. Nearly 80% of hospitalized patients receive intravenous drip during their treatments (2). In the US, over 300 million IV catheters are used by hospitalized patients annually (3).

Not all patients using IV infusion always lie down on the bed and do all activities on the bed. Most of them try to be independent in carrying out their daily activities such as bathing, urinating or defecating in the bathroom, or walking out of the ward to get fresh air. As a result of doing these activities, IV infusion flowing of the patients can be occluded or even completely stopped. In a normal situation, patients commonly use an infusion stand for safety. During mobilization, however, IV infusion must be stopped if the patients are using the infusion stand. It can make the infusion flow occluded. For this reason, an instrument is needed to maintain the IV infusion to keep flowing when the patients are doing mobile activities, so problems related to IV infusion will not occur.

Several previous studies indicated that most studies focused on creating electronic or digital infusion monitoring systems or infusion pumps which use electricity. This electric based system is normally heavy and considered high risk if it is used while mobilization (3–8). There is no study which attempts to create an instrument that helps the patients prevent occlusion of IV infusion flow during their mobilization.

For those reasons, researchers tried to develop an instrument called Digital Mobile Infusion Bag. It is a non-invasive instrument that maintains the flow of IV infusion fluid when the patients are getting out of bed and doing mobilization. It is simple, easy to use, hassle-free for patients or nurses, and effectively maintains the infusion flow. This instrument replaces the use of an infusion stand by which IV infusion must be stopped. If it is stopped too long, occlusion will occur, and IV infusion should be removed, and a new insertion may be made. A frequent insertion of IV cannula may increase the pain experience and infection rate of the patients. Finally, it reduces the quality of patient care(9). On the other hand, by using Digital Mobile Infusion Bag, infusion flow will be maintained

during patients' therapy mobilization. It can prevent occlusion when patients perform activities such as urinating, defecating, and bathing in the bathroom, or walking in and out of their wards. It also can reduce costs due to repeated insertion of IV set as in the case of using the infusion stand. This new instrument can also reduce the workload of nurses or physicians who must insert IV set many times. In addition, the new instrument can increase patients' satisfaction in using IV therapy, and it may enhance the quality of health care. This study was aimed at developing a Digital Mobile Infusion Bag which can be used to maintain the flow of IV infusion effectively and efficiently when patients are moving out of the bed.

**II. METHODS**

After obtaining ethical clearance from the ethics committee of the Faculty of Nursing, Universitas Riau with the letter-number 217/UN.19.5.1.8/KEPK.FKp/2021, this quantitative study started by developing the instrument and followed by testing the instrument. The researchers first developed the instrument before it was tested. This research project was carried out in the nursing laboratory of the Faculty of Nursing, Universitas Riau, Indonesia. The researchers used soft surfaces and thick fabric which was carefully sewn to develop the instrument. The Digital Mobile Infusion Bag is made of a 500 ml IV infusion using a plastic bottle. Many hospitals and other health care facilities in Indonesia are still using infusion plastic bottles. Since the bag is placed on the upper arm, the weight of a 500 ml infusion bottle is acceptable for adult patients. It is not recommended for elderly or younger patients.

**III. RESULTS**

A Digital Mobile Infusion Bag has been developed. It was made of materials that are strong enough to withstand a 500 ml plastic infusion bottle. This instrument ensures the safety and comfort of adult patients with intravenous infusion during mobilization and prevents occlusion. The bag is equipped with a belt that hangs around the patient's shoulder and upper arm so that the instrument and the infusion bottle will not come off. In addition, the infusion bottle is also covered by buckles so it will not fall. The instrument also has a balloon covering the infusion bottle holder (under the buckles) to provide controlled pressure for pushing the infusion fluid in the bottle to keep it flowing. The pressure given to the balloon was based on the Mean Arterial Pressure of the users. The balloon has a small tube that was connected to a small portable digital pump. The pump was used to give controlled pressure to the balloon. It increased the pressure in the infusion bottle making the fluid infusion flow higher. It subsequently made the infusion fluid keep flowing when the patient's hand injected by IV infusion is moved freely. Below is the figure of the design of the instrument and use of the instrument.

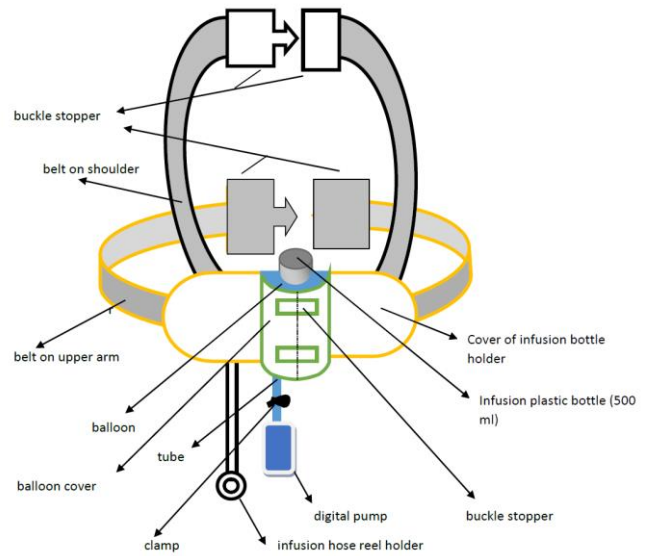


Fig 1. The Design of the Digital Mobile Infusion Bag



Fig 2. Use of Digital Mobile Infusion Bag: front view



Fig 3. Use of Digital Mobile Infusion Bag: side view



Fig 4. Inflating the balloon of Digital Mobile Infusion Bag using a digital pum

The steps to use the instrument are as follows:

- Measure the Mean Arterial Pressure (MAP) of the patient who will use the instrument. MAP is calculated using the formula:  $\text{systolic blood pressure} + (\text{diastolic blood pressure} \times 2) / 3$ .
- Make sure that the patient should be in a sitting or standing position before the instrument is placed on the patient's arm. It is only used when the patient mobilizes. It may not be set up while patients lying down on the bed.
- Place the mobile infusion bag on the patient's upper arm where there is the IV infusion. Fasten the belt on the patient's shoulder and upper arm.
- Transfer the patient's infusion bottle from the infusion stand to the instrument. Stop the patient's infusion first so that the blood does not go up to the IV line. After the infusion bottle is put on the holder, reset the number of the infusion drop.
- Connect the digital pump to the balloon to give controlled pressure. Inflate the balloon based on the pressure of the MAP. The MAP unit is mmHg. It can be converted to other units, such as  $1 \text{ mmHg} = 0.0013 \text{ atm}$ ,  $1 \text{ mmHg} = 0.0013 \text{ bar}$ , or  $1 \text{ mmHg} = 0.019 \text{ psi}$ . Tighten the clamp to prevent air leaks and remove the pump.
- Now the patients may move around freely such as walking, bathing, urinating, or defecating in the bathroom of the ward.
- After the patients finish with the mobilization and return to the bed, transfer the patient's infusion bottle to the infusion stand and remove the instrument.

#### IV. DISCUSSION

The Digital Mobile Infusion Bag can be used only by adult patients who are using a 500 ml plastic infusion bottle. This instrument is not recommended to use for glass or plastic bag infusion containers because they have a high risk to break when controlled pressure is applied. The digital pump is a bit heavy, therefore the pump was not hung on the instrument. It is used when inflating the balloon of the instrument. After the balloon is filled with air, the digital pump is removed so that it does not weigh on the patient's arm. The pressure given to this balloon is equal to the Mean Arterial Pressure (MAP) because the pressure of infusion fluid in the IV cannula is higher than in peripheral intravenous by using MAP so that the fluid will flow smoothly. MAP describes the average arterial pressure during one heartbeat cycle (10).

The range of peripheral Venous pressure is 10-30 mmHg while the pressure of fluid 100 cm above the cannulation site is around 75 mmHg. MAP of normal blood pressure is around 70-100 mmHg (3). IV cannula pressure range varies depending on gravity, fluid density, the height of the fluid, flow rate, and diameter of the cannula (11). However, resistance is a hindrance to fluid flow. The greater the resistance in the IV circuit, the higher pressure is required to obtain the needed flow(12). The internal diameter of IV tube, cannula, needles, and patient's vessel diameter all-cause additive resistance to infusion flow. It also happens to sticky solutions, length of infusion tube, and

flow rate, as well as the folded hose, that can accumulate to pressure given (10)(13). The instrument is required to accurately deliver adequate infusion flow to make the fluid flow higher than the pressure in the peripheral venous pressure constantly. These principles will be used to test the effectiveness of the instrument in the next step of this study.

This Digital Mobile Infusion Bag is recommended for patients who use IV infusion with a 500 ml infusion bottle because the weight of this bottle is not too heavy for the adult patient's arm. Although the instrument looks simple and easy to use, it has enormous benefits for patients who require mobilization during hospitalization. This instrument can keep the patient's infusion flowing smoothly even though the patient performs various hand movements. Mobilization is needed by patients to make the patients recover faster and be more independent. By using the instrument while mobilization, the patient's IV infusion flow will be maintained constantly, and at the same time it can reduce the risk of recurrent pain due to insertion of IV set for infusion, reduce the risk of infection, and improve the quality of nursing services for patients who are using IV infusion.

#### V. CONCLUSION

The Digital Mobile Infusion Bag is an instrument recommended to use for adult patients using IV infusion. The instrument can keep the patient's infusion flow moving smoothly when the patients move around their beds, such as walking to the bathroom and doing various hand movements. By using the instrument, it can reduce the risk of recurrent pain due to the release of a stopped infusion or the insertion of a new IV set. In addition, it can reduce the risk of infection due to repeated injection of IV set as well as reduce the cost of health care. It is hoped that the patient would have much better quality of health care services than before using this instrument. Furthermore, this instrument is a new way to prevent occlusion during mobilization for patients using IV infusion in hospitals and other health care facilities. Further studies are needed to test the effectiveness and efficiency of the instrument in preventing the occlusion of IV infusion flow during mobilization.

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#### Conflicts of interests

The authors declare no conflict of interest in conducting and publishing the study.

#### Ethics approval

Ethical clearance given by Ethic of the Faculty of Nursing, Riau University, number: 217/UN.19.5.1.8/KEPK. FKp/2021.

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