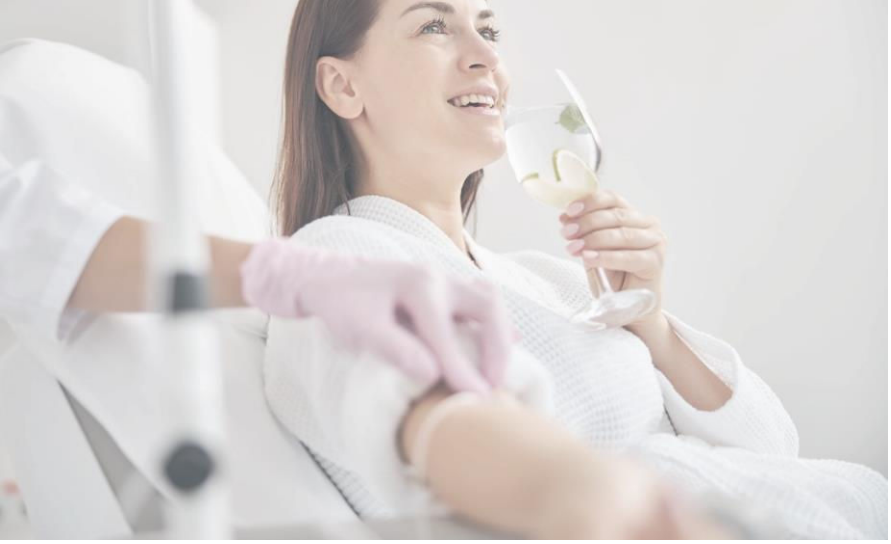

Enhance Patient Mobility in IV Therapies

ID Studio 7: A1 Research Report

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The Need of The Patient Comes First.

Abstract

This report focuses on the importance of improving patient mobility during IV therapy, as low levels of physical activity during hospitalization are thought to lead to a variety of negative patient outcomes. This report specifically aims to find alternative solutions to traditional IV stents. Various steps were taken to find design criteria through a literature review, a set of surveys for the public and two expert interviews. Qualitative and quantitative data were collected through surveys to gain a basic understanding of patient perceptions of IV therapy. Semi-structured interviews were conducted to find links between literature and insights. It was found that both secondary and primary studies led to the following results: problems with traditional IV braces include limited patient mobility, increased risk, and lack of individualized care. The findings suggest that the patient experience can be improved through the introduction of wearable technology, increased patient autonomy, and the use of new infusion device designs. Five different design concepts are proposed to address existing problems and enhance patient freedom and comfort. Finally, the key findings of the study are summarized and the potential for improving medical infusion therapy to provide a better patient care experience is highlighted. These findings have important implications for future healthcare design and practice.

Content

01 Introduction

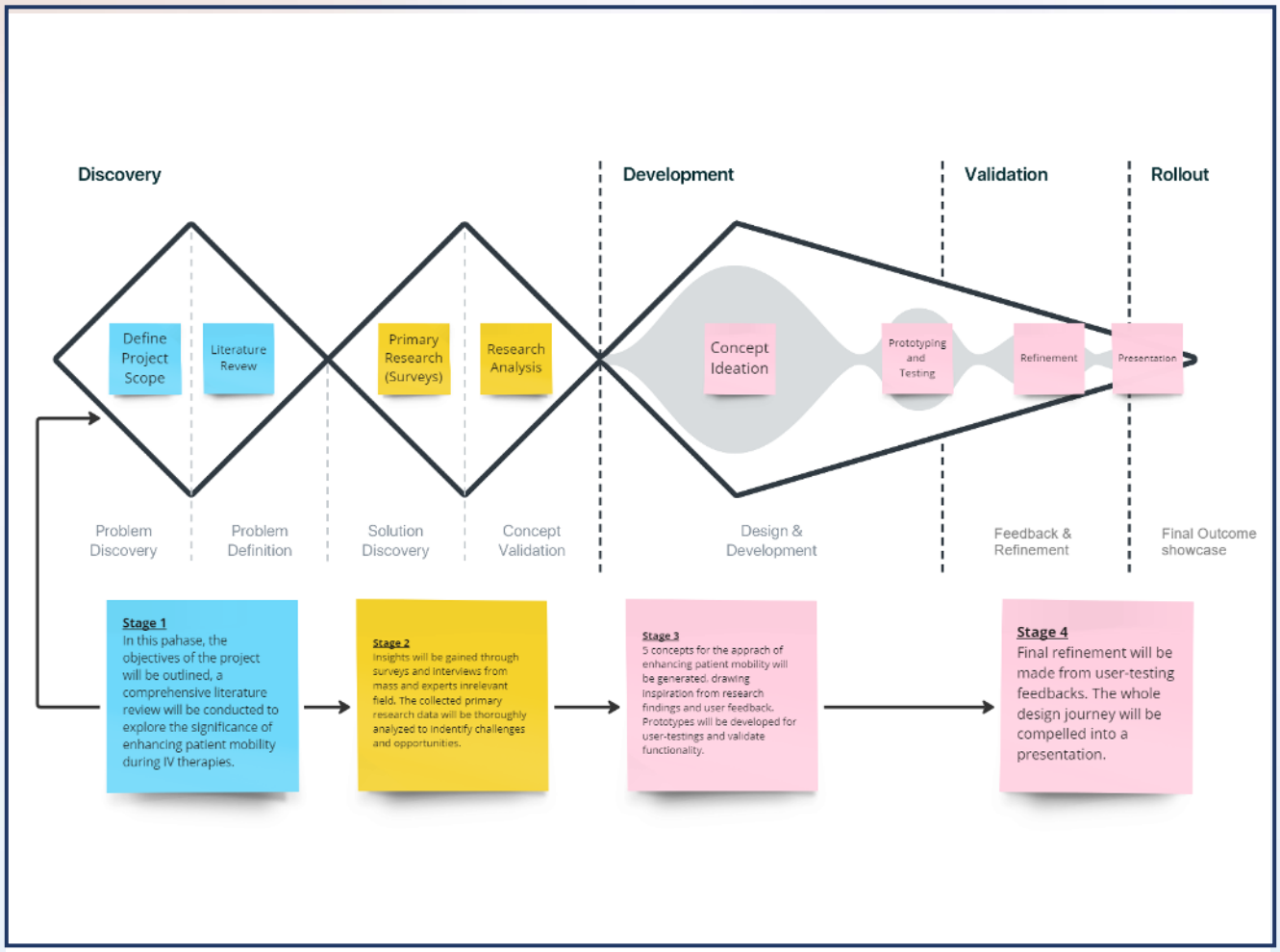
In the dynamic landscape of modern healthcare, the pursuit of innovation plays a pivotal role in redefining patient experiences and optimizing medical practices (Kelly & Young, 2017). As the demand for patient-centric care continues to shape the evolution of healthcare systems, it becomes imperative to critically assess and enhance every facet of the medical journey. Among the myriad interventions that form the cornerstone of medical treatment, intravenous (IV) therapy stands as a fundamental practice. However, the conventional approach to IV therapy, typified by the cumbersome IV pole, presents an array of mobility challenges that hinder both patients and healthcare providers. This research report embarks on a journey to explore a groundbreaking solution – a wearable IV device – which seeks to solve the problem of patient mobility issue during IV treatment and revolutionize the landscape of patient care.

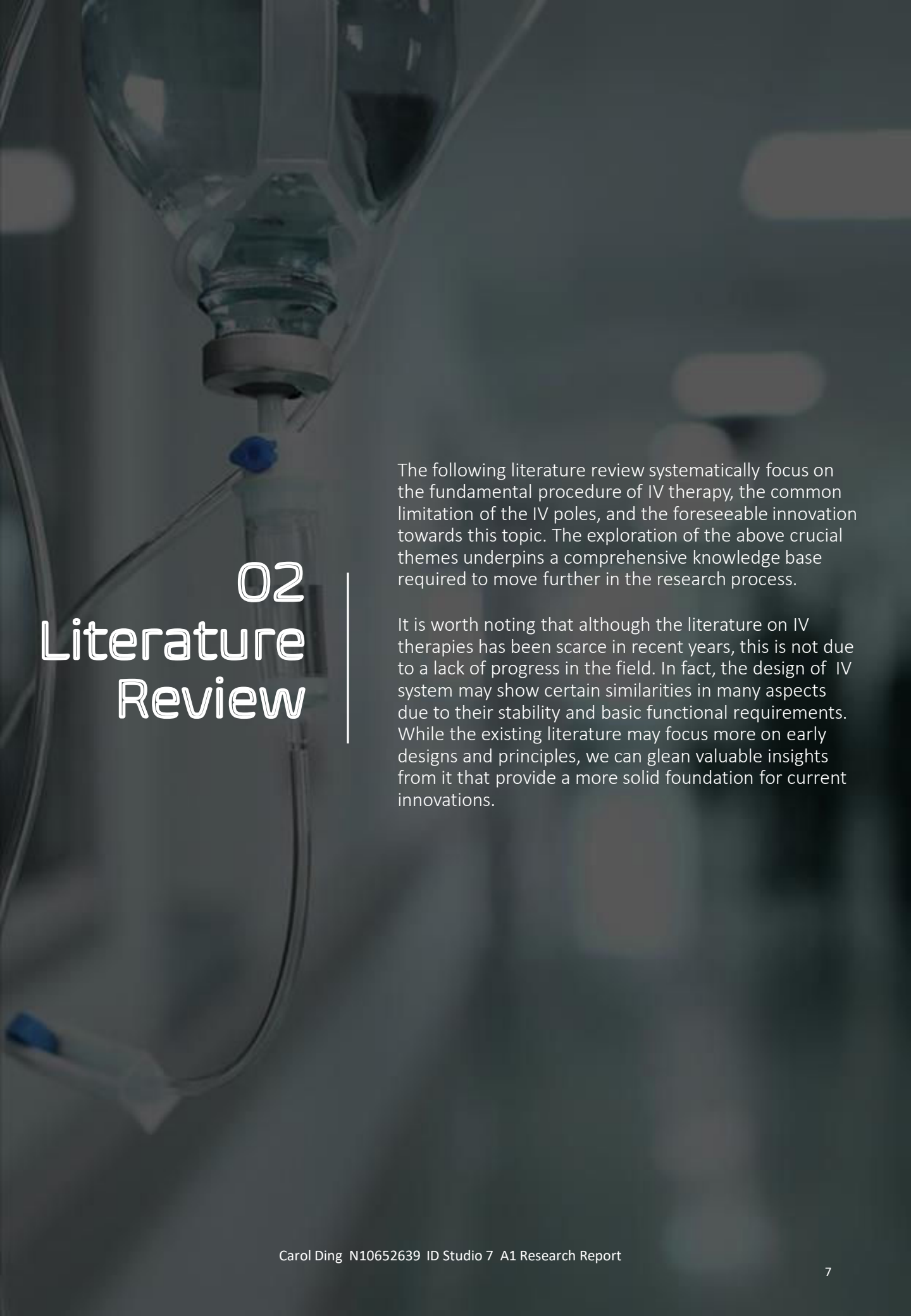
At the heart of this endeavor lies a profound motivation to address the multifaceted challenges that permeate the realm of IV therapy. The conventional IV pole, though undeniably crucial, is accompanied by an array of pain points that ripple through the fabric of healthcare provision. From restricting patients' mobility to hampering their ability to engage in daily activities, the stationary nature of IV poles curtails the essence of patient autonomy. The burden of constant monitoring falls upon both healthcare professionals and patients, impeding the vision of a seamless and efficient medical process. This project, rooted in the belief that innovation can be a catalyst for transformative change, sets out to redefine the contours of IV therapy by seamlessly integrating medical technology and human-centric design principles.

The significance of this project reverberates across a spectrum of healthcare contexts, each demanding its unique blend of adaptability, efficiency, and patient-centricity. The formidable challenges faced in diverse settings, ranging from bustling hospital emergency departments to remote outdoor rescue scenarios, call for a reimagining of traditional medical practices. By designing a wearable IV-infusion device that not only administers fluids but also embodies an array of intelligent features, such as temperature control, flow rate modulation, and real-time alarms, this project strives to pioneer a paradigm shift in patient care.

At its core, this research report aims to explore an innovative approach in enhancing patient mobility during IV treatment, drawing insights from existing research, technological breakthroughs, and successful interventions in various healthcare contexts. By envisioning a future where patients are unburdened by the constraints of stationary IV poles, and healthcare providers are equipped with an arsenal of tools that enhance their clinical prowess, this project aspires to usher in an era where innovation and compassion converge to shape the landscape of healing.

1.1 Graphical View of the project





02 Literature Review

The following literature review systematically focus on the fundamental procedure of IV therapy, the common limitation of the IV poles, and the foreseeable innovation towards this topic. The exploration of the above crucial themes underpins a comprehensive knowledge base required to move further in the research process.

It is worth noting that although the literature on IV therapies has been scarce in recent years, this is not due to a lack of progress in the field. In fact, the design of IV system may show certain similarities in many aspects due to their stability and basic functional requirements. While the existing literature may focus more on early designs and principles, we can glean valuable insights from it that provide a more solid foundation for current innovations.

2.1 Review of Current IV therapy

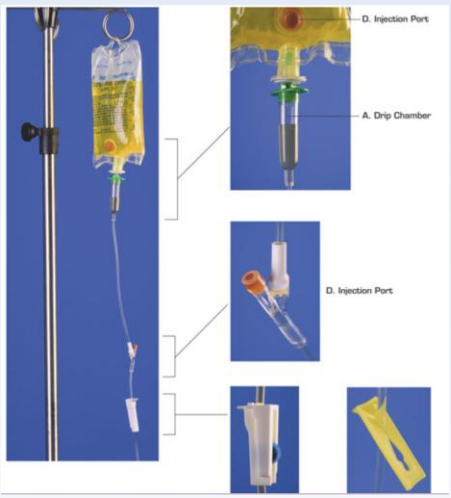
Intravenous therapy is a type of treatment that involves directly injecting intravenous fluids, drugs, blood, or blood products into a vein (Perry, Potter, & Ostendorf, 2014). In an emergency circumstance or for individuals who are unable to take drugs orally, intravenous therapy is an effective and fast-acting means to provide fluid or pharmaceutical treatment. Intravenous fluid, medication, and nourishment delivery is quite common in hospitals, accounting for up to 80% of medical practices for hospitalized patients (Waitt et al., 2004).

The principle of traditional infusion is based on the physical effect of hydrostatic pressure and atmospheric pressure, injecting liquid into human veins (Yuji, 2016). Usually, the infusion bottle is hung high to create a water column pressure, so that the liquid can enter the vein smoothly. However, this design must meet certain conditions: the height of the infusion bottle must be sufficient, the liquid level must be open to the atmosphere, and the water column pressure must be greater than the venous pressure. Therefore, the infusion bottle must be suspended high, and the top of the infusion tube has air holes to maintain balance. This restricts the patient's movement, because the infusion must be kept in a high suspension state to avoid backflow of blood, and the infusion bottle cannot be turned over and shaken(Yuji, 2016). **These restrictions impede the patient's free movement and cause inconvenience in during the treatment.** In modern designs, it is critical to explore ways to address these issues to provide more convenient infusion methods and enhance patient comfort and mobility.

Figure 1 shows a basic set up of IV therapy, the following are the general guidelines of IV therapies:

- - IV fluid treatment is prescribed by a medical professional and requires information such as solution type, infusion rate, duration, date, and time.
- - Because IV treatment is invasive, it might cause significant complications if the wrong fluids or drugs are given.
- - Maintaining aseptic technique is essential during all stages of IV treatment, including commencement, equipment maintenance, and termination(CDC, 2011).
- - When a vein must be maintained open ("TKVO"), the normal infusion rate is 20 to 50 ml per hour (Doyle & McCutcheon, 2015).
- - Localised infection, catheter-related bloodstream infection (CR-BSI), fluid overload, and difficulties relating to solution or medicine type and dosage are also potential consequences of IV treatment (Perry et al., 2014).
- - An infusing peripheral IV site requires regular examination, generally every 2 hours or as needed.

Figure 1: IV set up



(Ledis, 2022)

2.2 Existing IV poles

As mentioned earlier, patients' movement are strongly related to the constraints of IV poles . This section analyzes the current IV poles and their pros and cons from Kassem et al's study.

The existing IV poles can be distinguished into Market poles and research poles. Market/commercial IV poles are the most often used poles nowadays; they are made up of a stand, a wheeled base, and hooks that are assembled side by side, with the hooks attached to the top of the stand and the wheeled base attached to the bottom. These IV poles can be distinguished by their additional characteristics (Sayed-Kassem et al., 2020)..

Figure 2a depicts an ambulatory patient support stand having a horizontal support handle that facilitates in the movement of the stand. By pushing the pole while gripping the handle, the patient applies less force than would be required to push a standard IV pole. The Homecare IV stand, seen in Figure 2b, is constructed with the centre of gravity at its base (bottom section), which is connected to two rear supporting wheels and two front casters. The latter design enables for quick device installation and disassembly, as well as modification of the elevation of the IV bag based on the patient's height. Furthermore, as illustrated in Figure 2c, the hanging IV pole is a pole affixed to the roof right above the patient's bed. A drawback of such an IV stand is that it does not permit the patient to maneuver the pole; someone has to always hold the IV bag (Sayed-Kassem et al., 2020). Furthermore, the Brewer stand, seen in Figure 2d, is a free-standing mobile pole with improved hangers, accessories, and height adjustment.

Figure 2(a) *2(b)* *2(c)* *2(d)*

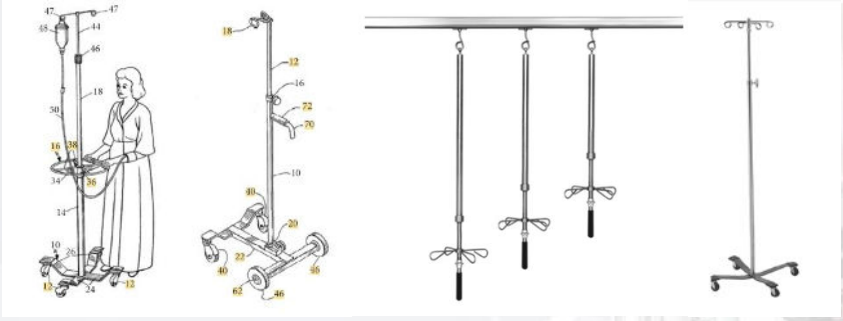


Figure 2 (a-d): (Sayed-Kassem et al., 2020)

Figure 3: Advantages and disadvantages of existing IV poles

IV pole types	Method	Advantages	Disadvantages
Research IV poles	Autonomous IV stand	Automated movement	High cost (>2000); complex design; no wireless communication between the nurse and the IV pole; can carry only one IV bag, i.e., can withstand a low weight; consumes a lot of power
	Novel robotic IV pole	Semiautomated movement; saline sensor and alarm; can carry several IV bags; can be manually controlled	Needs patient training; not accurate sensing; no obstacle detection; power consuming
Commercial IV poles	Ambulatory patient support stand	Stable; resembles the walker; helpful for patients with walking difficulties	Occupies a lot of space
	Homecare IV stand	Easy assembly and disassembly; lightweight	Low load capacity, i.e., can hold slight weight merely
	Hanging IV pole	Occupies lower space; low probability of transporting bacteria	Limited mobility area; requires nurse assistance; absence of a place to attach a medical equipment
	Brewer stand	Simple design; high strength; high system stability; smooth movement; most popular	Limited mobility of patients; requires nurse assistance
	Dyaun IV stand	Brake on the wheels	Unstable design

The disadvantages of current poles summarized in Figure3 were centered on their cost, **the space they occupy, how they are maneuvered, and the lack of crucial features.** In essence, the inherent limits shared by different IV pole designs as shown in Figure 2(a-d), such as **restricted mobility and patient reliance**, inspire designers to find innovative solutions. The constant challenge is to develop solutions that address these limits while still **improving patient comfort, autonomy, and overall healthcare experience.**

2.3 Risks of restricted mobility

According to multiple studies, it is proven that existing intravenous poles on the market restricted patients' movement and took up both the patient's and the nurse's time (Sayed-Kassem et al., 2020). According to a survey conducted in 2015 on 629 nurses, 85.7% of the participants have claimed that they have felt a risk of falling when patients use IV poles (Hachigasaki, 2020). **Walking with an IV pole could impact a person's stride.** Walking in a straight path while using an IV pole shortens stride, decreases pace, and minimises arm swing compared to walking normally, according to research done by Hachigasaki (2012) on healthy persons in their 60s. These findings suggest that while walking with an IV pole, even a healthy person's gait approaches that of an elderly person or someone who has fallen.
In Hachigasaki's study, he has conducted a study examining directional changes while walking with an IV pole, 33 healthy men participated (Hachigasaki, 2020). The experiment recreated IV drip placement in the left forearm, with the pole maneuvered using the left hand. Six movements, including turns and stopping, were executed, capturing gait measures and subjective assessments.
Results indicated distinctive alterations when walking with an IV pole. Turns and walking with the pole correlated with reduced speed, prolonged time, shorter stride, and head angle tilt. Turning left without stopping often involved contact between pole legs and participants' legs (15.2%), showing higher probability compared to other movements. Subjectively, turning left without stopping led to a diminished sense of security ($p<.05$) compared to turning left with stopping. Conclusively**, turning with an IV pole increases fall risk due to the pole itself.**

2.4 The innovation

Considering the risk of falling is a common limitation, a recent study by Oguri et al., suggests an innovative approach to the danger of falling events related with manually pulling IV poles while walking. The study proposes a robotic IV pole design that travels autonomously besides the user to reduce the danger of falling. The system employs LiDAR technology to calculate the user's centre of gravity, guaranteeing proper alignment with the location of the IV pole. Experiments validated the suggested algorithm's efficacy, allowing the robotic IV pole to synchronise with walking rates ranging from 0.3 m/s to 0.8 m/s (Oguri et al., 2021). This study emphasizes the need of patient movement when using an IV pole once more. However, this research demonstrates that the robotic IV pole has largely addressed the standard IV pole's **auto-moving capability** while **preserving the traditional size and design.**

Figure 4: Robotic IV

(Kem, 2022)

Another innovation on this that is already in the market is the portable-iv set as shown on the right. The Ez Pole is a portable IV stand designed and manufactured by Mobiu Co., Ltd in Korea that allows patients to move freely while receiving an IV. It consists of three main components: a shoulder hook, a stand and a bottle holder. In addition, there are soft shoulder pads and two quick snap straps that go around one shoulder and the chest. As a result, the weight of the bottle is evenly distributed over the body to minimize stress on the shoulder area. However, although this design allows the patient to move independently, this design may obstruct the field of vision as much as possible. In addition, it **does not change the form of the fluid container**, which can **add a lot of weight to the patient**.

Figure 5: EZ Pole

(Savroprex, nd)

2.5 Importance of person-centered care

Patient-centered care is a key component of person centric care, **giving the patient a sense of control and responsibility** so that the patient is involved in the care activities (both psychologically and physically) in order to benefit and recover from this involvement (Kashyap, 2023). Low levels of physical activity during hospitalization are considered to contribute to a variety of negative patient outcomes (Szeto et al., 2023). Therefore, **enhancing the patient's freedom and mobility is essential in the treatment process.**

As shown in figure 6, the Korean YouTube Blogger Nado is conducting outdoor activity with an IV pole besides, claiming in her post that she has experienced 4-day-5-night IV therapy. According to research, It's known that for common vitamin therapies, The 500mL IV drip usually takes between 20-40 minutes, and the 1000mL IV usually takes 30-60 minutes (*INTRA V*, 2023). Depending on the patients' age and weight, and the IV type, the duration can be varied between 15 and 90 minutes minutes (*AZ IV Medics*, 2020). The average hospital stay are varied between 4.44 days and 11.6 days (Burgess & Lewis, 2000).

Figure 6: Nado went outdoor with IV pole

(Nado_odo， 2023)

Appropriate patient activity not only helps to reduce physical complications, but also improves the patient's social and emotional well-being. However, in traditional IV therapy, patients are required to press an alarm button when they need help or seek assistance when they need to use the restroom, which can limit patient autonomy. If patients are given more autonomy and control over these necessary needs, their needs can be better met and their treatment experience can be enhanced (Javed, 2023). Therefore, providing patients with **more decision-making power and autonomy** can help build a closer therapeutic partnership, thereby enhancing treatment outcomes and patient satisfaction (J, 2014).

2.6 WIDs used nowadays

Using **wearable medical devices during hospitalization may help improve patient activity,** sedentary behavior, and other outcomes (Szeto et al., 2023). Multiple recent literatures have pointed out the opportunities of using wearable injection devices. The emerging concept of wearable devices (WDs), implantable devices (IDs), and combined wearable and implantable devices (WIDs) for drug delivery has opened up new avenues for treating patients with chronic diseases that require ongoing and long-term medical attention, such as diabetes, ocular disorders, cancer, wound healing, cardiovascular diseases, and contraception (Kar et al., 2022). However, the literature has also mentioned a significant technical challenge that in the notion of WDs is their restricted capacity to contain a high drug payload, making them appear less suited for applications requiring high-dosing.

There has been publications related to wearable injectors, such as the example wearable injectors shown in figure 7a&b, and these devices are primarily used for diabetic patients. As chronic diseases require long-term treatment, daily tasks such as insulin injections can be burdensome for patients (Gross, 2022). As a result, continuous technological innovations and increased patient awareness have led to the widespread acceptance of an increasing number of wearable devices. However, current wearable syringes are predominantly used for the injection of small volumes of fluids, and thus an area of research exists in which there is a lack of portable, lightweight wearable devices suitable for the infusion of fluids. The only wearable IV infusion device on the market was shown in the previous section in Figure 5, however it is not convenient enough and lightweight for mass use. This research area provides an important opportunity to **explore the development of novel wearable technologies suitable for infusion therapy to improve patient mobility and treatment experience.**

Figure 7a

Figure 7b

(Ondrug Delivery Magazine, 2022)

2.7 Conclusion

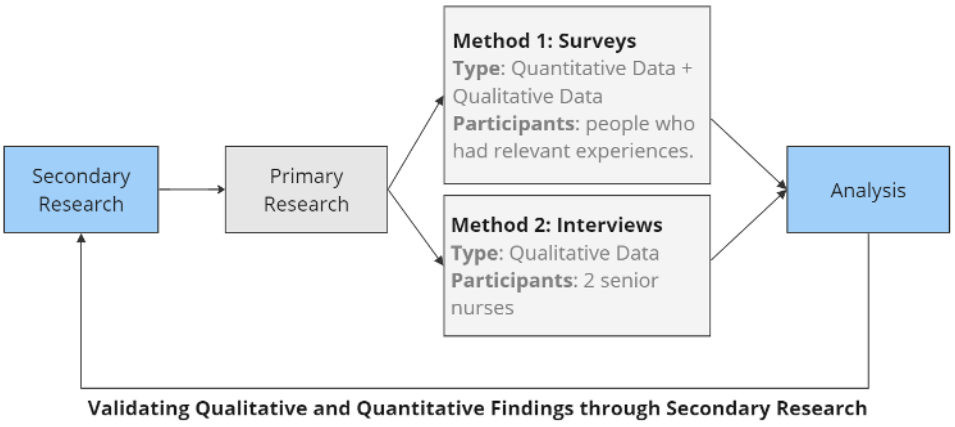
The literature review has highlighted the importance of enhancing patient mobility in IV therapy, as the current approach causes potential risks of patient falls. Further research suggests that the wearable techniques can be integrated into the design to enhance patient comfort and enhance mobility. there are some innovation but they are not perfect, the robotic IV pole shown in Figure 4 can walk with patients side by side, but its size is not changing, and can also be very crowded in the ward; the wearable design in Figure 5 is too big and heavy to stand on patients' shoulders, the visin will be blocked too. The research gap identified is that current market lack of the convenient and lightweight wearable infusion device that eligible for using in IV therapies. This research area provides an important opportunity to explore the development of novel wearable technologies suitable for infusion therapy to improve patient mobility and treatment experience.

03 Research Overview

Design research is an important element in generating the optimal possible user experience, as it assists designers in comprehending users' behaviour and translating it into practical insights to improve the design (Esposito, 2018).

The key objective of the study is to measure respondents' thoughts on the need for alternate IV pole solutions in various healthcare scenarios. The survey and interviews sought to ascertain participants' understanding of the limits of conventional IV poles, their opinions of the possible benefits of wearable IV-infusion devices, and their readiness to embrace such alternatives.

Figure 5: Primary research structure



3.1 The surveys

The first collection method was a survey developed to people with experiences with IV therapies in any health care scenarios. The survey consists of 12 questions and took an average time of 4 minutes to complete. Survey questions were structured to collect both quantitative and qualitative data.

To gain thorough insights from participants, the survey included a combination of closed-ended and Likert scale questions, that would easily translate to meaningful insights once reviewed. Three optional open-ended questions are also included to provide insights. The survey responses were given by a varied spectrum of respondents, including persons from various healthcare backgrounds and age groups, all participants have had experiences with IV therapies.

The research questions that the survey aims to address include:

1. How well do people recognize the inconvenience of the current IV poles?
2. What are the current challenges relating to the IV poles?
3. Would people see wearable IV set as an innovative approach or unnecessary?

3.2 Expert interviews

The second collection method consists of 2 face-to-face semi-structured interviews to two senior nurses. The interviews were conducted in person and was intended to provide qualitative data that to validate findings from the secondary research, while also addresses the research gaps.

Professional insights can provide practical recommendations for design research, as well as identifying possible strengths and limitations of new designs. Interaction with senior nurses can lead to a better understanding of current issues in actual clinical practice and incorporate these insights into research to better meet the needs of patients and healthcare professionals.

04 Analysis & Findings

Based on research methods, both quantitative and quatitative data were collected. The following section will provide analysis of the insights and interpretation drawn from the surveys and interviews, in order to generate interpertation for validating the secondary research. The full survey results and interview transcripts are provided in Appendix 1&2.

4.1 Collection method 1: Surveys

Considering the significant amount of patients who have experiences in IV therapies, the online survey was open to everyone, aiming to understand people's experience when conducting IV therapies,. According to the sruvey results, all of the 43 participants claimed that either themselves or their family members have recieved IV therapy. The survey results is shown in Appendix 1.

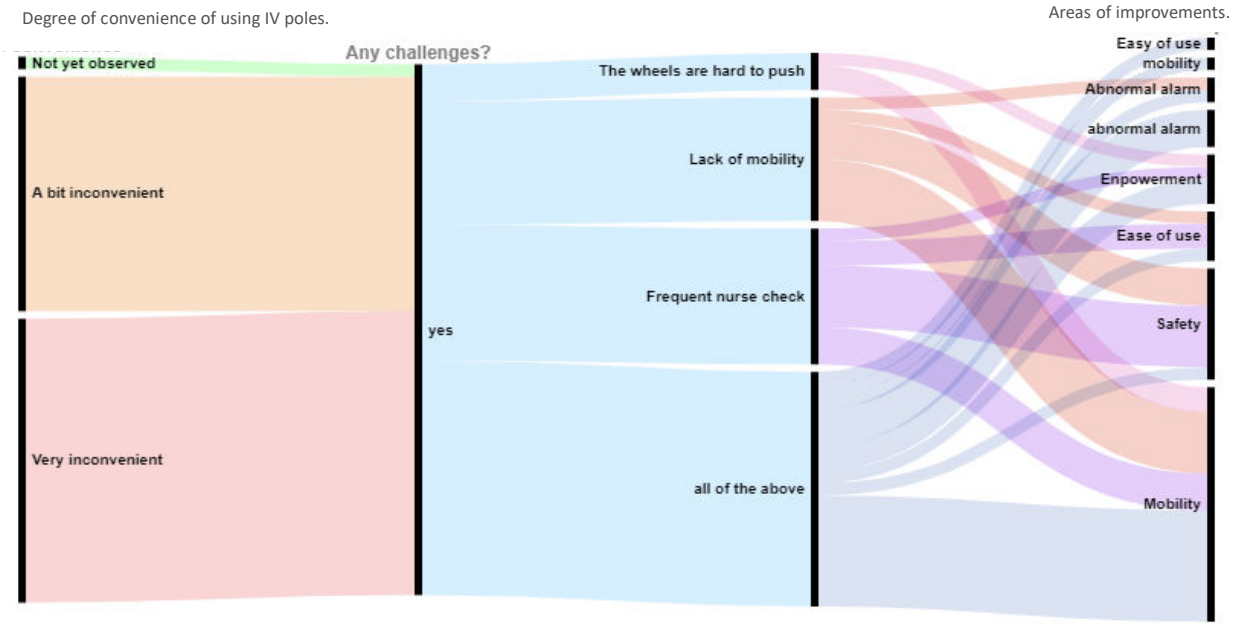
4.1.1 Significant raw data results

Accoridng to the raw data, 55.8% said they were aware of significant limitations and inconveniences associated with IV poles, while 41.9% felt somewhat inconvenient, 81.4% of the people said that they or their family members encountered challenges when receiving intravenous treatment, such as inconvenient to go to toilet, or tripping over by the long tubes. These results have strong correlations, which has proven that there is significant challenges in regards to the design of the IV stand.

When discussing the worst aspects of an IV treatment setup, 7% claimed the wheels were difficult to push, 25.6% claimed that the need for regular check-ups by a nurse, 25.6% stated lack of mobility and feeling restricted, and 41.8% claimed that all problems listed exist.

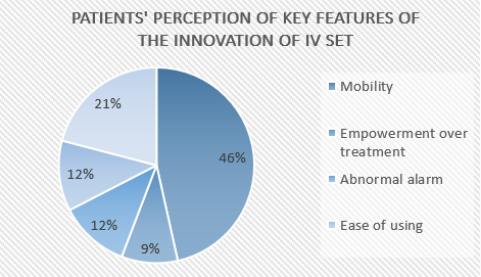
In evaluating patients' perceptions towards the possible wearable innovation, 79.1% were familiar with the concept of wearable medical devices, while 67.4% could imagine that integrating wearable IV infusion devices would improve the overall patient experience. With 83.7% believed that wearable IV devices designed to provide more mobility and comfort would positively impact their experience during medical treatment.

In the last close-ended question, 63.4% stated that, given the choice, they would personally prefer a wearable IV infusion set over a traditional IV stand, provided the redesigned wearable IV set was implemented. Also, 28.6% claimed they would try it when most people started. Figure below is an alluvial diagram showing some selected data.



The open-ended question focused on what key features would the patients expect to see in the new design. Upon reviewing the responses, it is evident that nearly 50% of the answers focused on the issue of limited mobility, with many respondents expressing a desire for independent and unrestricted access to facilities such as toilets. To better understand the qualitative data gained in the open-ended question, 5 themes are created to group the answers. The number of responses relate to each theme are shown as the graph on the right.

Open-question results



4.1.2 Analysis

Through the analysis of these raw data, some correlations can be seen. According to the survey, more than half of the participants were aware of the limitations and inconveniences of the IV stand, while when discussing the worst aspects, most felt that the problem was multifaceted, including difficulty with wheel pushing, frequent nurse checks, and lack of mobility and comfort. Responses to questions three and seven revealed that many felt that solutions that provided more mobility and comfort would help improve their overall experience. Responses to questions six and eight indicate that most people are familiar with the concepts of wearable medical devices and wearable IV infusion sets and are willing to try these innovative solutions. Moreover, to ascertain the degree of completion and successful submissions, the 2 open-ended questions were optional to fill in. Surprisingly, the completion rate reached 87.2%, indicating a notably high participation rate, implies that it is quite straightforward and easy to think of the challenges that current IV therapies posts.

4.1.3 Key findings

Taking these results together, it can be concluded that many in the field of intravenous therapy are aware of the limitations of traditional IV stands, the following dot points summarizes the key findings during the survey:

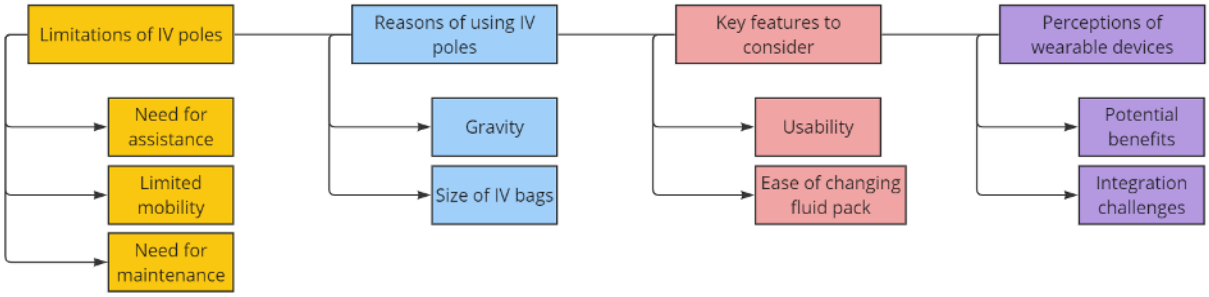
Patients have expressed a keen interest in providing **better mobility, comfort, and innovative solutions**.

Key features patients would like to see in the new design: **Lightweight and portable, abnormal alerts, manage independently**.

Key challenges of current IV pole**: hard to push, inconvenient to go to toilet,** always **in need of companionship and nurse checking.**

Collection method 2: Expert interviews

Two extensive semi-structured expert interviews were conducted and coded to identify key themes. The 2 interviewees, Maggie and Viola, are both senior nurses. The interviews are both recorded and transcribed in Appendix 2. Below shows the themes and codes of the interview.



in terms of conventional IV poles, both participants pointed out their major limitations in the healthcare setting. Maggie emphasized the heavy weight of existing IV poles, the inconvenience of moving them, and their tendency to cause patients to fall. She also pointed out that long tubes can become entangled in the patient, causing additional distress. Viola, on the other hand, emphasized how IV poles not only restrict the patient's mobility in tight ward spaces, but also cause inconvenience to other patients and healthcare professionals. She also mentioned the old and rusty wheels of the IV poles, which may make pushing difficult for patients with weak hands. All these issues were verified in the observations of both experts.

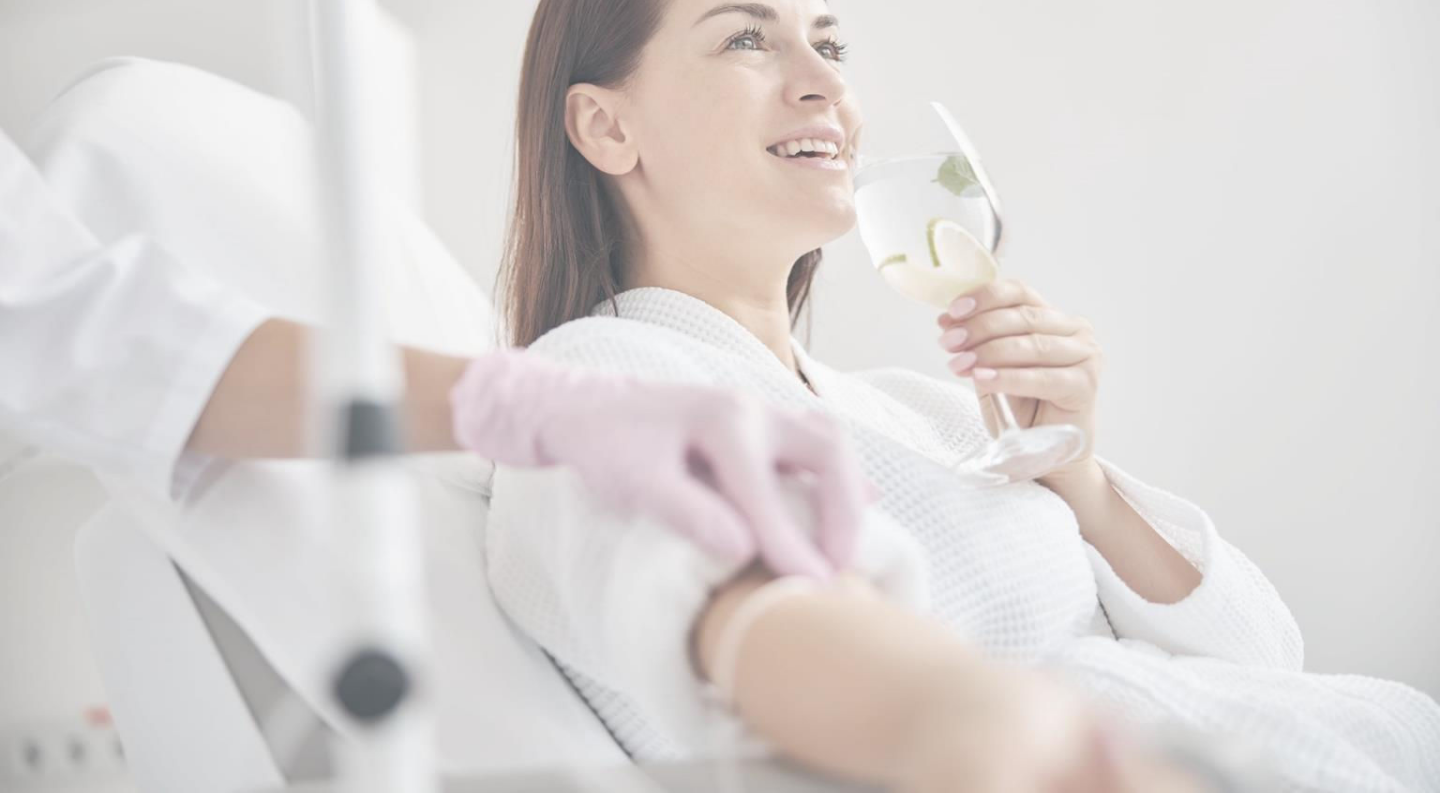
Another important finding was that both experts saw the potential for wearable technology to solve the IV stent problem. They both agreed that designing drug delivery devices in a wearable form could increase patient freedom, reduce dependence on others, and enable patients to move more autonomously. However, they also pointed out some potential challenges, such as solving the blood reverse issue, comfort of wearing the device, and size limitations.

In addition, the two experts emphasized the importance of patient experience and engagement in healthcare. They argued that wearable devices can enhance patient comfort and enable them to participate more actively in the treatment process, thereby promoting recovery.

In summary, Maggie and Viola's interviews revealed the various limitations of IV stents in traditional healthcare settings and the potential of wearable technology to address these issues. Their insights provide important direction for the future development of more advanced IV treatment options.

Below are examples of quotes from the interview transcript divided into their respective codes and themes.

Theme	Code	Examples
Limitations of IV poles	**Need for assistance**	**Maggie**: Well, the current IV poles are quite heavy and often require assistance to move, especially when the IV pump needs to be charged. Sometimes, staff has to unplug the pump before moving it, which can be a bit cumbersome.
	Limited mobility	**Maggie**: Many patients, particularly those confined to bed, face mobility limitations. I've seen patients struggle to get out of bed for tasks like using the restroom because the IV pole is heavy and awkward to manage. **Viola**: Patients often struggle to move around comfortably due to the weight and size of the IV pole. This is particularly noticeable in wards where space is limited, causing inconvenience to both patients and staff.
	Risk of falling	**Maggie**: Falls are a significant concern. They not only pose risks to patients but also increase the workload for healthcare staff. A fall could potentially harm not only the patient using the IV pole but also others in the vicinity. The lengthy tubing can also pose a tripping hazard and cause entanglement issues, especially being problematic when patients need to reach for something or move around. **Viola**: Many patients inadvertently trip over the IV poles while trying to move around. This poses a risk to their safety and requires attention from the medical team.
	Need for maintenance	**Maggie**: The wheels on the IV pole can also be tricky to maneuver, making it less convenient to push around. **Viola**: Patients with weaker hands may find it difficult to push the heavy and sometimes rusty poles.
Reasons of using IV poles	**Gravity**	**Maggie**: The principle is that to use gravity and liquid pressure to deliver the liquid into the patient's body. So the placement of the needle and IV bag should be taken into consideration. **Viola**: Additionally, if the IV bag is positioned below the patient's body, gravity may not work effectively.
	Size of IV bags	**Maggie**: IV bag sizes can vary from 200ml to 3l, which can be very heavy.
Key features to consider	**Usability**	**Maggie**: The key features would be ensuring proper blood flow, lightweight design, and easy usability. These factors would make the wearable solution effective and patient friendly. **Viola**: Ensuring proper dosage control and patient comfort would be crucial.
	Ease of changing fluid pack	**Viola**: Ensuring ease of use, including take on and off, change fluid pack... and patient comfort should be the primary focus when designing wearable alternatives. **Maggie**: If the IV bag requires changing, can the patient manage it independently, or would assistance still needed from others?
Perceptions of Wearable devices	**Potential benefits**	**Maggie**: If we shift to wearable alternatives, it would eliminate the need for assistance and provide patients with more freedom. Patients could move around independently without relying on someone else to move the IV pole...Wearable devices could greatly enhance patient experience by granting them more mobility and control over their treatment. **Viola**: Patients could engage more actively in their care, which is beneficial for their recovery.
	Integration challenges	**Maggie**: One challenge is ensuring that the wearable solution addresses the issue of insufficient height for proper blood flow. Also, the devices need to be lightweight and comfortable for patients to wear, without adding to their discomfort. **Viola**: Wearable solutions might have size limitations, which could impact the type of medications that can be administered. Also, managing the flow rate accurately is a challenge due to different tube sizes and potential blockages.



05 Discussion

Based on the literature review and primary research, various insights and findings were identified. This section will examine the connection between the two techniques, and to further validate the research gap.

The importance of addressing mobility issues and improving patient autonomy in IV therapy is highlighted by connecting the literature review to the primary studies. The literature review revealed an important research gap in that lack of patient mobility in IV therapy may lead to a risk of falls. The findings of Hachigasaki et al. further emphasized that even healthy individuals are at an increased risk of falls when using IV poles. Through interviews, experts unanimously stated that patient falls during treatment are a serious problem for both patients and nurses.

In addition, the literature review mentioned the possibility of wearable devices, which utilize wearable technology to enhance patient mobility. According to the research, this is also possible if key issues such as blood reflux and size limitations are addressed. Therefore, wearable devices offer a potential solution to address mobility issues in IV therapy. Both the literature review and the expert interviews validated the issue of patients needing to manually press an alarm button to signal the need to go to the toilet or get out of their seat, whereas patients would prefer to be able to move around freely and autonomously. This idea was further supported in the survey, as the results showed that 39% of participants expressed a desire to be able to easily get to the restroom, access other hospital facilities, and be able to perform necessary actions independently.

Furthermore, the experts have expressed concern that the size of the fluid pack might be an obstacle in designing a wearable device, as the amount of medicine can be varied from 50 ml to 1000ml. The weight of the fluid is an essential aspect to consider, it has proven by Kar et al., as the literature claimed that there is a significant technical challenge that in the notion of WDs is their restricted capacity to contain a high drug payload, making them appear less suited for applications requiring high-dosing.

Finally, although the materials used for IV poles are not discussed in detail in the literature, both the survey and the expert interviews highlighted the issue that the poles' wheels are often old and rusty, which may have an impact on patient mobility and comfort. This suggests that in future studies, material selection needs to be considered to improve the quality and suitability of IV stents. Therefore, by combining a literature review with primary research, this study emphasizes the urgency of addressing mobility issues in IV therapy and improving patient autonomy to provide a safer, freer, and more comfortable treatment experience.

06 Design implications & Initial Concepts

From the previous researches, important insights have been drawin in redesigning IV sets, the opportunity for the new design lies in the innovative use of wearable technology to address the mobility issues of traditional IV stands, allowing patients to move more freely.

First, the design should focus on lightness and portability to ensure that patients are able to move freely without external assistance. This requires rethinking the structure and materials of the device to reduce the burden on the patient. Second, the integration of intelligent control systems can enhance the patient's therapeutic experience by enabling them to manage the infusion process autonomously. In addition, the location and fixation of the IV bag needs to be carefully considered to ensure that it does not interfere with the patient's mobility and comfort. Durable materials and an easy-to-maintain design will extend the life of the device and reduce maintenance costs. Most importantly, the design should emphasize the patient's self-control, allowing them to autonomously manage common needs such as going to the bathroom or performing other activities. Finally, smart alerts and safety features should be part of the design to ensure patient safety and monitoring by the healthcare team. These insights will help develop IV infusion devices that are more responsive to patients' needs and improve the effectiveness of treatment and patient comfort.

The design implications can be summarized as the following:

Must

- The device must be comfortable to wear, ergonomic considerations should be addressed.
- The device should allow the users to move easily.
- The device must detect any abnormality, for example there is bubble/ pressure in the line, the tube/ fluid pack is left empty.
- The alarm system should be activated if detected any abnormality, also when the treatment is about to finish. The alarm system should connect to the medical professionals.
- Emergency stop switch will be turned on automatically when the alarm rings, to avoid excessive waiting times for nurses to come.
- The wearable device should be able to adjust the flow rate.

Should

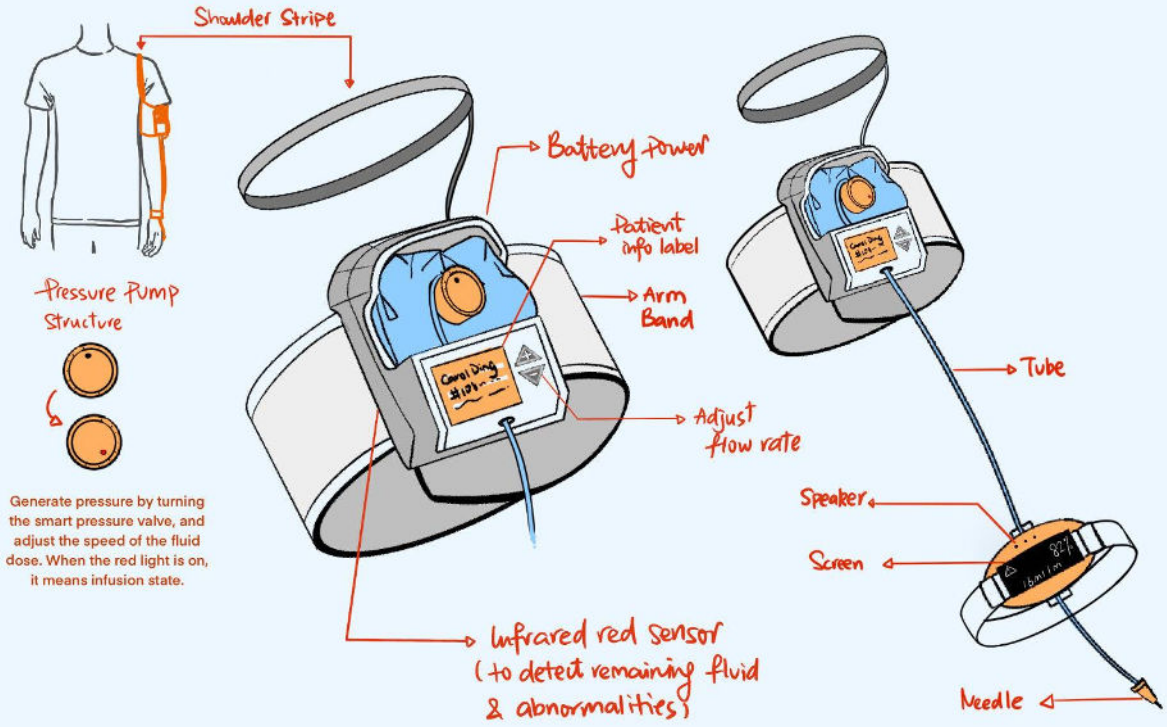
- Battery compartment or charging port should be considered.
- Comfortable to use in every position, not limited to walking (lying, sitting, etc.).

Must not

- Adding too much weight to the patients.
- Occur blood reverse.
- Insufficient alert features.

Concept 1

Arm Set for Small size IV bag



Scenario

- In-hospital care

Key Problem Targeted

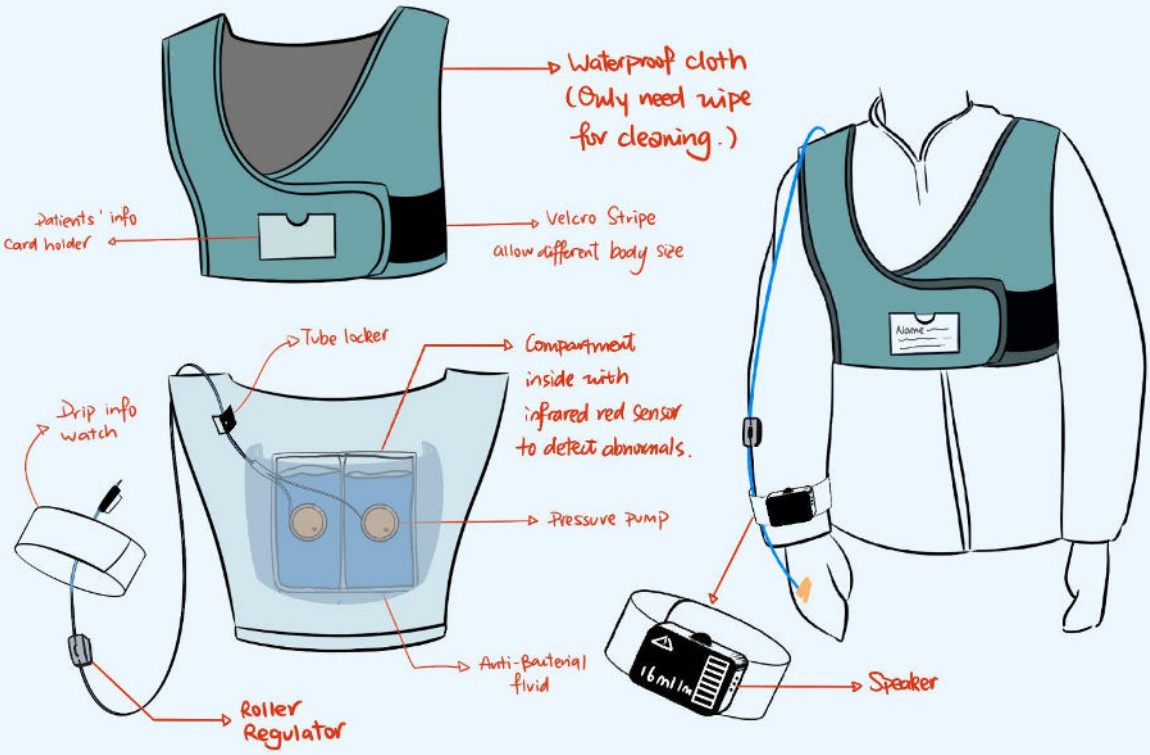
- Limited Mobility.
- Bulky and heavy IV stand with rusty wheels.
- Avoid large contact area to the body, ideal for smaller size IV bags.

Key features

- Container with a large opening for easy IV bag replacement.
- Pressure pump structure with built-in smart pressure valve and pressure sensor.
- Pressure can be adjusted by turning the valve.
- Shoulder strap enhances stability and prevents device from falling off the arm.
- Roller regulator for patients to adjust the flow rate within set limits.
- Infrared structure detects abnormalities and monitors IV fluid capacity.
- Data sent to a linked smartwatch for real-time alerts, fluid speed, and remaining capacity.
- Smartwatch display provides user information and connects to the nurses' end for monitoring.

Concept 2

Iv garment Set for big size IV bag



Scenario

- In-hospital care

Key Problem Targeted

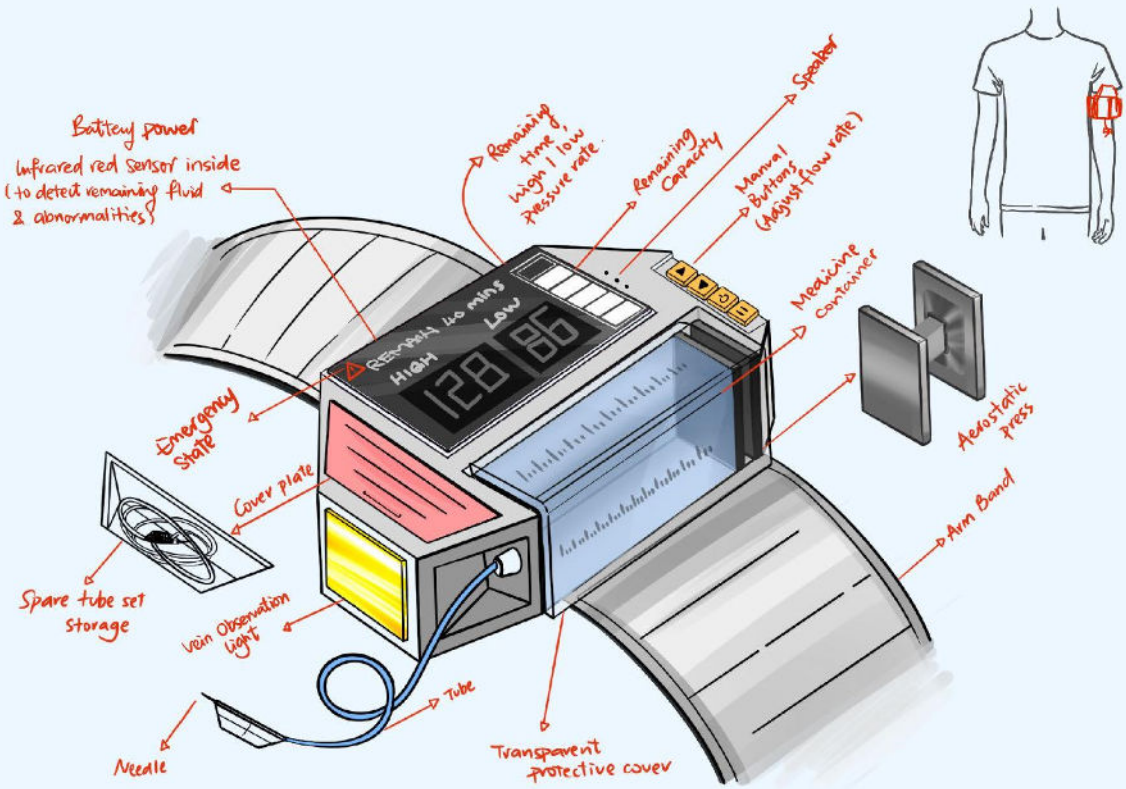
- Wearable solution for heavy IV bag.
- Avoid contact on arm.

Key features

- Transparent acrylic pocket for holding large-volume IV bags or accommodating two different fluid types.
- Velcro stripes structure for adjusting the garment to fit various body sizes.
- Pressure pump structure with a built-in smart pressure valve and pressure sensor, enabling height-independent use.
- Pressure adjustment through a valve.
- Shoulder strap for enhanced stability and prevention of device falling off the arm.
- Roller regulator for patients to adjust the flow rate within set limits.
- Infrared structure to detect abnormalities and monitor IV fluid capacity.
- Data sent to a linked smartwatch for real-time alerts, fluid speed, and remaining capacity.
- Smartwatch display provides user information and connects to the nurses' end for monitoring.

Concept 3

Iv arm Set for post-disaster rescue



Scenario

- Outdoor rescue/ post-disaster rescue/ emergency situations

Key Problem Targeted

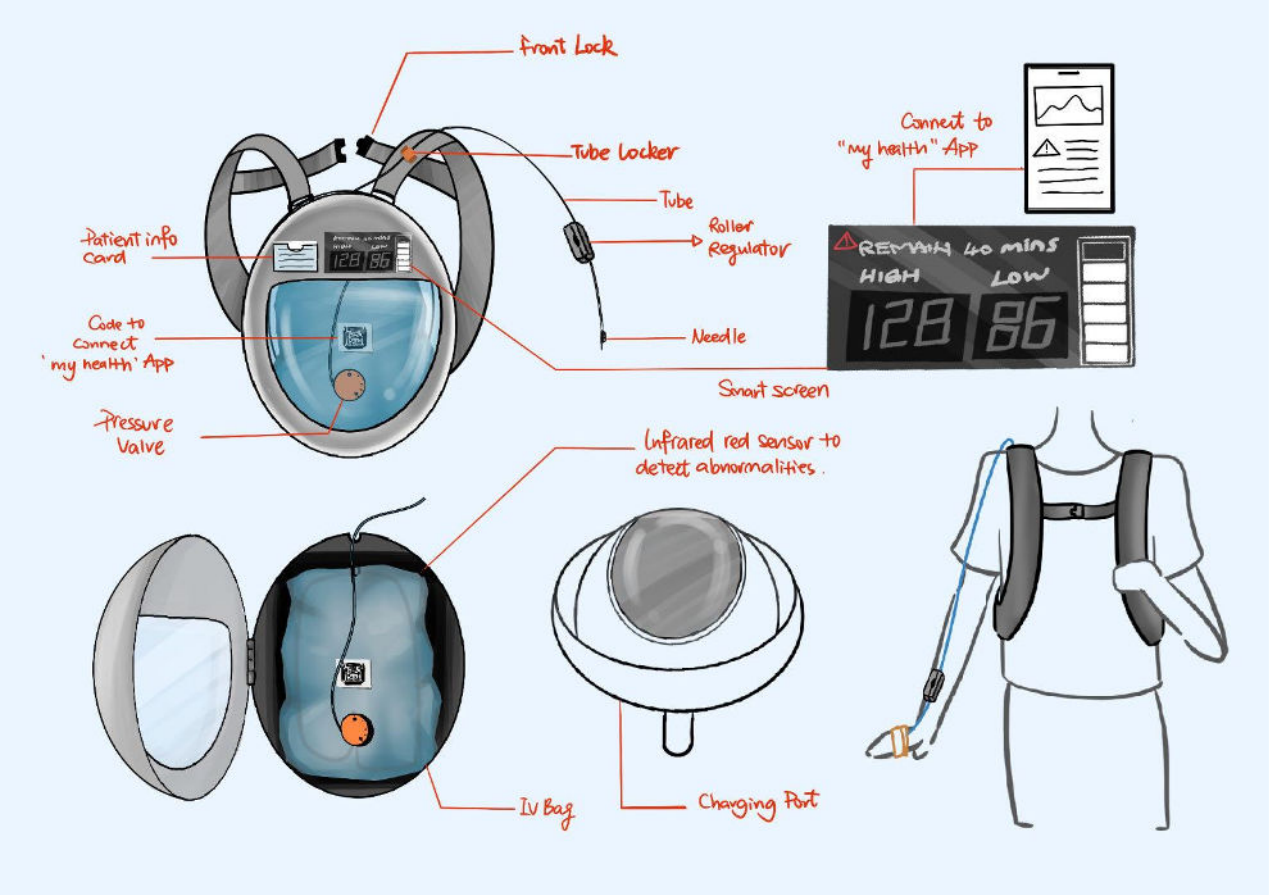
- Addressing the issue of limited space for IV poles when many people are injured.
- Reducing the need for long walks to safe areas during emergencies.

Key features

- The red cover plate can be opened to access the storage room for spare IV tube set.
- Yellow light at the front for clearer vein observation, especially useful in emergencies or darker areas.
- Top two buttons for patients to adjust the flow rate within set limits.
- Third button for turning the device on/off, with the last button serving as a pause button to halt the pressure pump operation, preventing sudden cardiac distress.
- Long-press buttons to activate functions, reducing accidental touches.
- Device screen displaying alert status, pressure rate, remaining capacity, and time.
- Pressure pump structure utilizing aerostatic pressure.
- Infrared structure to detect abnormalities and monitor remaining IV fluid capacity.

Concept 4

Backpack-like wearable IV set



Scenario

- In-Hospital Care

Key Problem Targeted

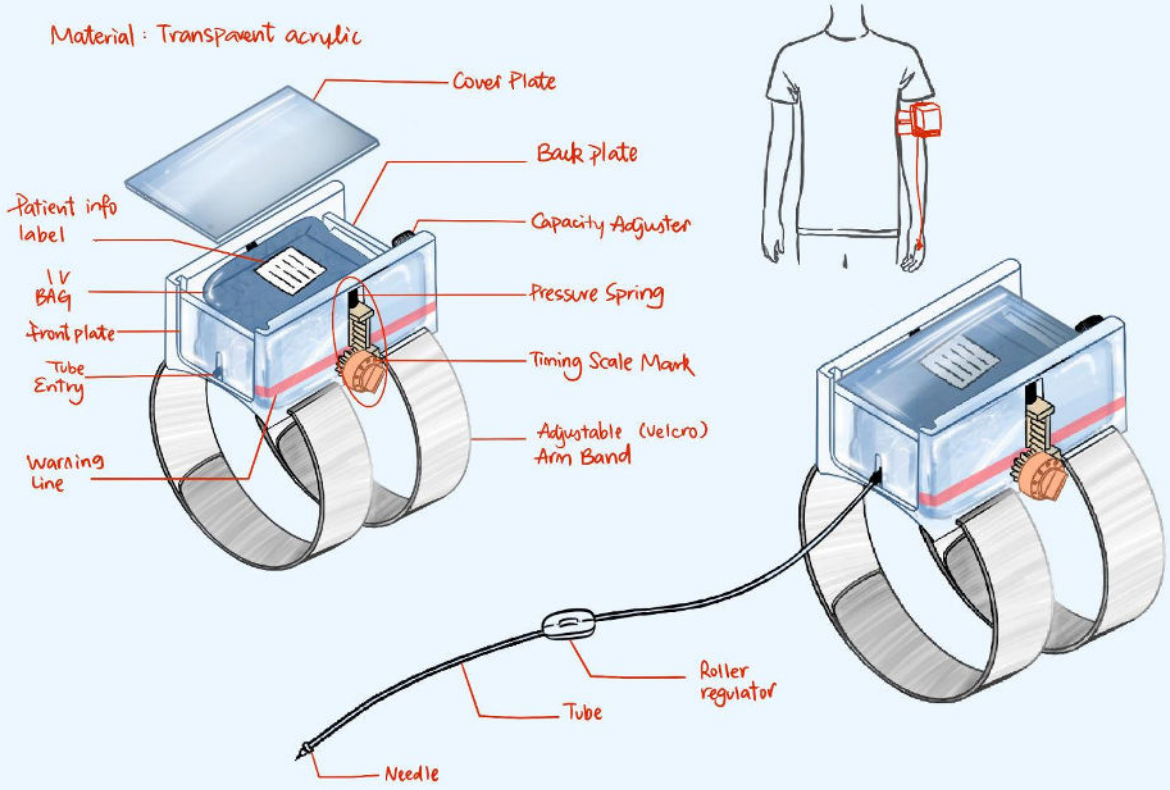
- Increase patient freedom during long-time treatment.
- Enhance patient empowerment.
- Wearable solution for large volume IV bag.

Key features

- The ergonomic design of backpack form allows users to move around comfortably, with pressure of the weight of IV bag lies evenly on both shoulder.
- The pressure pump structure with built-in smart pressure valve and pressure sensor, allows the user to use it without the limitations of height. Pressure can be generated by turning the valve by medical professionals before the treatment starts.
- The screen on the bag pack shows the alert status, fluid speed and remaining fluid capacity. It is linked to the nurses' end, as well as patients' health App on the phone.
- The two front strips are better reinforced for solidity, reducing the risk of dropping the pack to none.The shoulder strip is enhancing the stability, avoiding the device falls off from arm.
- The roller regulator can be used for patients to adjust the flow rate, with a maximum and minimum value.
- Infrared red structure in the device detects any abnormal and remaining capacity of the IV fluid, sending to the smart watch on the wrist.
- The device can be charged.

Concept 5

Mechanical IV arm set



Scenario

- In-Hospital Care

Key Problem Targeted

- Limited mobility, rusty old wheels, inconvenient to access facilities in hospitals.
- Pure mechanical movements, no electricity required, avoid any risk caused by electrical faults.
- Minimizes patient errors, such as mispressing buttons, for increased safety and reliability.

Steps of using

1. Remove the front cover plate and adjust the timing mechanism.
2. Insert the IV fluid bag into the groove.
3. Adjust the capacity control knob according to the IV bag's volume, ensuring the rear cover plate moves forward or backward to keep the fluid level even and not compressed.
4. The IV bag, in contact with both the cover plate and the rear cover plate, starts to experience squeezing.
5. Install the front cover plate.
6. The user wears the device and adjust the straps for a secure fit.
7. During the infusion, as the timer automatically rotates, the rack uniformly descends.
8. Under the action of a pressure spring, the cover plate slowly compresses the IV bag, creating pressure to complete the infusion.
9. When the infusion is finished, the timer triggers an alert to signal the completion of the IV infusion.

07 Conclusion

Through an in-depth analysis of the literature review, surveys, and expert interviews, this report uncovers the various approach of enhancing patient mobility during IV treatment.

The literature review revealed the limitations of traditional IV infusion devices, including restricted **patient mobility, potential safety hazards, and limitations on patient autonomy**. The results of the survey and expert interviews further confirmed the reality of these issues, highlighting the needs and challenges of patients and healthcare professionals in this area.

Patient voices became particularly important in the survey and expert interviews, emphasizing the **critical importance of portability, comfort, and safety** to IV device design. Patients are eager to be able to maintain their freedom and independence while receiving treatment without having to rely too much on healthcare professionals. The expert interviews also mentioned the importance of maintenance and materials of IV devices, which are directly related to the reliability and long-term sustainable use of the devices.

Based on this, a series of conceptual IV infusion device designs were proposed that aim to address the problems associated with traditional devices. These design concepts emphasize **lightweight, portability, intelligent control and patient autonomy,** as well as safety and maintainability. These concepts will provide new directions for future IV therapy devices, enabling better patient participation in the treatment process and improving overall efficiency and comfort.

In summary, this study provides insight and guidance for improving patient mobility during IV therapy. By focusing on patient needs, designers can create smarter, more user-friendly, and efficient devices that will improve the patient experience, reduce the burden on healthcare professionals, and improve the quality of healthcare delivery. These innovative design concepts are expected to bring positive changes to the healthcare industry, making IV treatments safer, more convenient and responsive to patients' needs.

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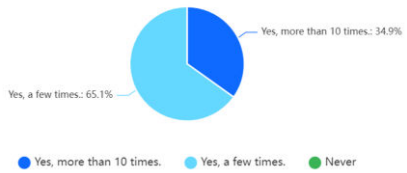
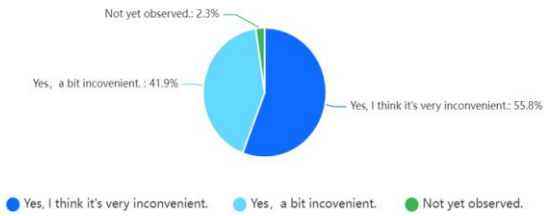
09 Appendix

Appendix 1: Survey Results

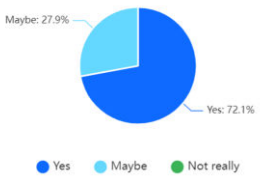
1. Have you or a family member ever received medical treatment involving intravenous (IV) therapy?



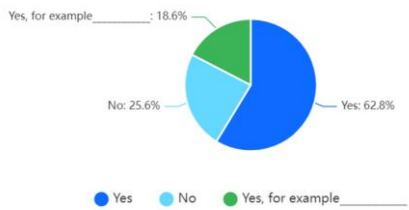
2. In your experience, are you aware of the limitations and inconveniences associated with IV poles?



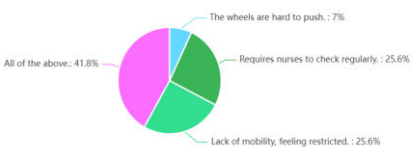
3. Based on your experience, do you believe that enhanced mobility and greater freedom during your treatment would improve your overall experience?



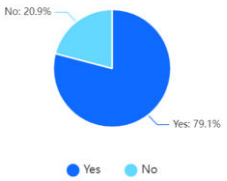
4. Have you or a family member ever faced challenges while undergoing IV therapy?



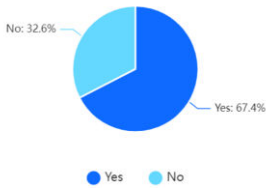
5. Which aspect do you most dislike about the current IV setup?



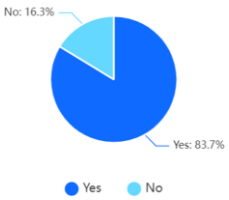
6. Are you familiar with the concept of wearable medical devices?



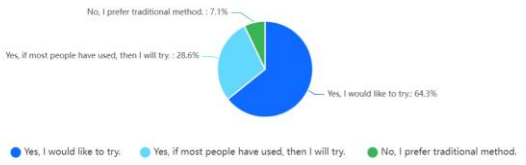
7. Can you envision the integration of wearable IV-infusion devices improving the overall patient experience?



8. Do you feel that a wearable IV set, designed to provide more mobility and comfort, would positively impact your experience during medical treatment?



11. If the redesigned IV set is implemented, would you personally prefer a wearable IV-infusion device over a traditional IV pole if given the choice?



*Results for Question 9 & 10 are shown in next page.

Survey Result Count.

9. In which healthcare contexts do you think wearable IV-infusion devices would be most beneficial? (Outdoor/ Indoor?)

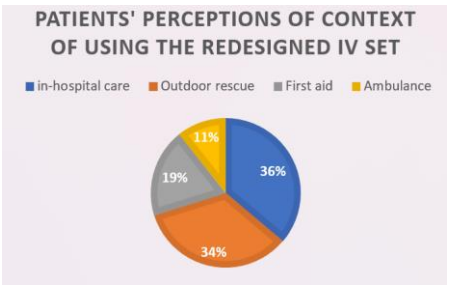
43	To substitute IV pole in the ward
42	Outdoor Rescue
41	In-hospital care
40	Children department (they are active)
39	Places where patients/injured need to move by themselves, such as outdoor rescue. If the patient is inconvenient or unable to move and can only lie down, there seems to be no special need for wearable infusion.
38	Use for patients who need regular treatment
37	Outdoor Rescue
36	Those with mild symptoms do not need long-time rest.
35	Family First-aid
34	Nursing Home
33	Outdoor rescue
32	Outdoor rescue
31	Outdoor Rescue
29	For those who have no one look after
28	Outdoor Rescue
27	Without anyone to take care.
26	In-hospital care
25	Outdoor Rescue
24	Patients who are able to move freely while getting out of bed will benefit.
23	In-hospital care
22	In-hospital care
21	In hospital care
20	Inpatients
19	Outdoor Rescue; Family First-aid
18	Schools, children's institutions.
17	Schools, children are active
16	Schools, sports and recreational facilities, as well as various children's institutions.
15	emergency
14	People with mobility issues (requiring the use of a wheelchair) experience significant inconvenience in personal movements.
13	Ambulance
12	People with limited mobility in the small ward.
11	Home first aid, emergency care, outdoor rescue, ambulance.
10	Outdoor rescue
9	Outdoor Rescue, Individualistic lifestyle
8	For home, outdoor emergencies, and indoor use, it can also save space.
7	Outdoor Rescue
6	Save yourself
5	It would be most beneficial in emergency situations and home infusion scenarios, as mobility is necessary in both cases. However, in the context of outdoor rescue and ambulance services, wearable infusion devices have certain limitations and might potentially waste valuable rescue time.
4	Outdoor Rescue
3	Ambulance
2	Outdoor Rescue and emergency
1	Inpatients

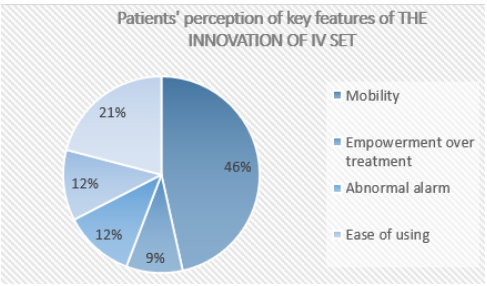
in hospital care
Outdoor rescue
Schools & family first aid
Ambulance

10. What features would you expect to see in the redesign of the wearable IV set?

43	I want a wearable infusion device with portability and abnormal alerts.
42	I want a device that can manage independently.
41	Pressure
40	Abnormal alarm
39	The infusion travels through the elevated manufacturing point, utilizing gravity and liquid pressure to deliver the medicinal liquid into the patient's body. In the case of a wearable device, would you need to maintain specific high and low positions for the medicine bag and the needle insertion site? Would additional equipment be necessary to ensure the seamless delivery of the medication solution? The placement of the needle and medicine bag locations must be taken into consideration. If the dressing pack requires changing, can the patient manage it independently, or would assistance still be needed from others? Additionally, how can patients be reminded to remove the needle or replace the medicine bag after liquid medication infusion?
38	Abnormal alarm
37	Catheters should exhibit a certain degree of resistance to compression and bending.
36	Doesn't disrupt normal routines, such as driving, meals, meetings, etc., limited to mild cases without affecting the treatment course.
35	Easy to use
34	Add an extra layer of safety protection, such as detecting the concentration and type of medication to prevent air from entering.
29	Lightweight
28	Usable while in motion
27	Convenient to go to toilet.
26	Convenient for inpatient using the restroom.
25	Convenient for using the restroom.
24	Doesn't need to always keep vertical.
21	Usable while in motion, but safe first
20	Portable, easy to use
19	Reverse flow alert
17	Easy to change medicine/ fluid pack
16	Portable, and also safe to use
15	Prevent patients from bending their arms, which could hinder the smooth circulation of medication.
13	Usable while in motion
12	Easy to change medicine/ fluid pack
11	Patients can move with it independently, conveniently, and safely.
10	The wearer can independently perform certain necessary actions.
9	The patient's hands can be liberated, enabling them to move freely without the need for assistance from others.
8	Video instructions, usage manual, and app connectivity for recording.
7	Usable while in motion
6	Safety is the priority
5	It offers the flexibility to adapt to different age groups and body sizes. Additionally, it can promptly detect and alert in case the patient makes any movements that could potentially damage the infusion tubing and bags.
3	Portable and usable while in motion
2	Usable while in motion

Mobility
Empowerment over treatment
Ease of using
Abnormal alarm
Safety





Appendix 2a: Semi-structured interviews

Interview Outline and Guiding Questions

Introduction

1. Could you please describe your primary responsibilities and typical tasks in your role as a senior nurse?

Patient's challenges toward current IV poles

2. What do you perceive as the main limitations of traditional IV poles in healthcare settings?
3. Have you encountered any situations where patient mobility while connected to an IV pole was restricted?
4. In your opinion, how significant is the risk of patient falls related to limited mobility when using traditional IV poles?

Nurses' challenges toward current IV poles

5. Have you encountered any challenge with the current IV poles?

Envision future

6. How do you envision the integration of wearable techniques in designing alternatives to traditional IV poles?
7. What potential challenges or concerns do you foresee in adopting wearable solutions for IV therapy?
8. How do you perceive the impact of wearable devices on patient experience and engagement in their healthcare?
9. Any other thoughts to add for this project.

Appendix 2b: Participant consent forms

CONSENT FORM FOR CAPSTONE RESEARCH PROJECT
Interview

Exploring the alternatives of IV poles

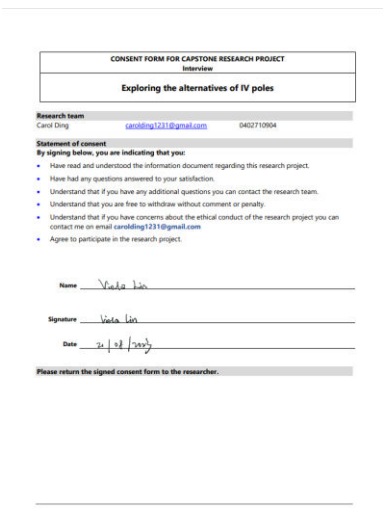
Research team
Carol Ding carolding1231@gmail.com 0402710904

Statement of consent
By signing below, you are indicating that you:

- Have read and understood the information document regarding this research project.
- Have had any questions answered to your satisfaction.
- Understand that if you have any additional questions you can contact the research team.
- Understand that you are free to withdraw without comment or penalty.
- Understand that if you have concerns about the ethical conduct of the research project you can contact me on email carolding1231@gmail.com
- Agree to participate in the research project.

Name
Signature
Date

Please return the signed consent form to the researcher.



CONSENT FORM FOR CAPSTONE RESEARCH PROJECT
Interview

Exploring the alternatives of IV poles

Research team
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Statement of consent
By signing below, you are indicating that you:

- Have read and understood the information document regarding this research project.
- Have had any questions answered to your satisfaction.
- Understand that if you have any additional questions you can contact the research team.
- Understand that you are free to withdraw without comment or penalty.
- Understand that if you have concerns about the ethical conduct of the research project you can contact me on email carolding1231@gmail.com
- Agree to participate in the research project.

Name Viola Lin
Signature Viola Lin
Date 31/08/2023

Please return the signed consent form to the researcher.

Appendix 2c: Interview transcripts

Interviewee 1: Maggie, 2-year senior nurse, working in Melbourne

Interviewer: Hi Maggie! Thank you so much for taking the time to chat with me today.
Maggie: Of course, happy to help!

Interviewer: Great! Let's dive right into it. Could you please describe your primary responsibilities and typical tasks in your role as a senior nurse?
Maggie: Sure! As a senior nurse, I oversee patient care and provide guidance to the nursing staff. My responsibilities include coordinating patient treatments, administering medications, and ensuring proper procedures are followed. I also collaborate with doctors and other healthcare professionals to develop care plans and monitor patients' progress.

Interviewer: That sounds like a vital role. Now, let's talk about traditional IV poles. What do you perceive as the main limitations of traditional IV poles in healthcare settings?
Maggie: Well, the current IV poles are quite heavy and often require assistance to move, especially when the IV pump needs to be charged. Sometimes, staff has to unplug the pump before moving it, which can be a bit cumbersome. The wheels on the IV pole can also be tricky to maneuver, making it less convenient to push around.

Interviewer: I see. Have you encountered any situations where patient mobility while connected to an IV pole was restricted?
Maggie: Absolutely. Many patients, particularly those confined to bed, face mobility limitations. I've seen patients struggle to get out of bed for tasks like using the restroom because the IV pole is heavy and awkward to manage. This can be quite frustrating for them.

Interviewer: It's definitely a challenge. How significant do you think the risk of patient falls related to limited mobility when using traditional IV poles is?
Maggie: Falls are a significant concern. They not only pose risks to patients but also increase the workload for healthcare staff. A fall could potentially harm not only the patient using the IV pole but also others in the vicinity. The lengthy tubing can also pose a tripping hazard and cause entanglement issues, especially being problematic when patients need to reach for something or move around. Additionally, falls caused by IV poles are not only a safety concern but also create additional tasks for the medical team.

Interviewer: Your insights are invaluable. How do you envision the integration of wearable techniques in designing alternatives to traditional IV poles?
Maggie: If we shift to wearable alternatives, it would eliminate the need for assistance and provide patients with more freedom. Patients could move around independently without relying on someone else to move the IV pole. But IV bag sizes can vary from 200ml to 3l, which can be very heavy, the size might be limited if that's wearable.

Interviewer: What other potential challenges or concerns do you foresee in adopting wearable solutions for IV therapy?
Maggie: One challenge is ensuring that the wearable solution addresses the issue of insufficient height for proper blood flow. Also, the devices need to be lightweight and comfortable for patients to wear, without adding to their discomfort. But if the IV bag requires changing, can the patient manage it independently, or would assistance still needed from others?

Interviewer: Valid points. How do you perceive the impact of wearable devices on patient experience and engagement in their healthcare?
Maggie: Wearable devices could greatly enhance patient experience by granting them more mobility and control over their treatment. This empowerment could lead to better engagement and overall satisfaction.

Interviewer: Do you believe that wearable devices could address the limitations associated with IV pole mobility and patient comfort?
Maggie: Absolutely. Wearable solutions could alleviate many of the issues we've discussed, making it easier for patients to move and be more comfortable during treatment.

Interviewer: In your opinion, what are the most important features that should be included in wearable alternatives to traditional IV poles?
Maggie: The key features would be ensuring proper blood flow, lightweight design, and easy usability. These factors would make the wearable solution effective and patient-friendly.

Interviewer: Thank you so much, Maggie. Your insights have been incredibly helpful. Is there anything else you'd like to add for this project?
Maggie: Just that it's an exciting direction to explore. Wearable alternatives have the potential to revolutionize how patients experience IV therapy, and I'm curious to see where it leads.

Interviewer: That's a fantastic perspective. Thank you again for sharing your expertise, Maggie!
Maggie: You're welcome! It was my pleasure to help.

Interviewee 2: Viola, 1-year senior nurse, working in Brisbane

Interviewer: Hi Viola! Thank you for joining me today for this discussion.
Viola: You're welcome! Happy to share my thoughts.

Interviewer: Great! Let's jump right in. Can you please describe your primary role and typical tasks as a senior nurse?
Viola: Absolutely, I oversee patient care, manage nursing staff, and ensure that protocols and procedures are followed accurately. My role includes patient assessments, medication administration, and collaboration with the medical team.

Interviewer: Thank you. Now, considering IV poles, have you encountered situations where patients' mobility while connected to an IV pole was restricted?
Viola: Definitely, it's quite common. Patients often struggle to move around comfortably due to the weight and size of the IV pole. This is particularly noticeable in wards where space is limited, causing inconvenience to both patients and staff.

Interviewer: Those are important points. In your view, how significant is the risk of patient falls related to limited mobility when using traditional IV poles?
Viola: Patient falls are a significant concern. Many patients inadvertently trip over the IV poles while trying to move around. This poses a risk to their safety and requires attention from the medical team.

Interviewer: Absolutely. Have you encountered any other challenges with the current IV poles?
Viola: Yes, there are a few. Patients with weaker hands may find it difficult to push the heavy and sometimes rusty poles.

Interviewer: Shifting focus a bit, how do you visualize the integration of wearable techniques in designing alternatives to traditional IV poles?
Viola: Wearable alternatives could bring decent improvements. But certain factors like gravity and medication quantity must be considered.

Interviewer: True. What potential challenges or concerns do you foresee in adopting wearable solutions for IV therapy?
Viola: Ensuring proper dosage control and patient comfort would be crucial. Also, wearable solutions might have size limitations, which could impact the type of medications that can be administered. Also, managing the flow rate accurately is a challenge due to different tube sizes and potential blockages.

Interviewer: Those are important considerations. How do you think wearable devices might impact patient experience and engagement in their healthcare?
Viola: If it is implemented successfully, it would enhance patient mobility and comfort, ultimately improving their overall experience. Patients could engage more actively in their care, which is beneficial for their recovery.

Interviewer: In your opinion, what are the most important features that should be included in wearable alternatives to traditional IV poles?
Viola: Ensuring ease of use, including take on and off, change fluid pack... and patient comfort should be the primary focus when designing wearable alternatives.

Interviewer: Thank you, Viola. Your insights are invaluable. Is there anything else you'd like to add for this project?

Viola: Just that for one, patients must have their entry portals removed when discharged, so I'm not sure if your wearable can be used outside hospital context. Additionally, if the IV bag is positioned below the patient's body, gravity may not work effectively. Moreover, controlling the flow rate can be challenging due to different tube sizes and potential blockages.

Interviewer: These are good points to research. Thank you so much for sharing your expertise, Viola!
Viola: My pleasure.