

Exploring Using Personalised Comics for Healthcare Communication for Patients Living With Hemodialysis

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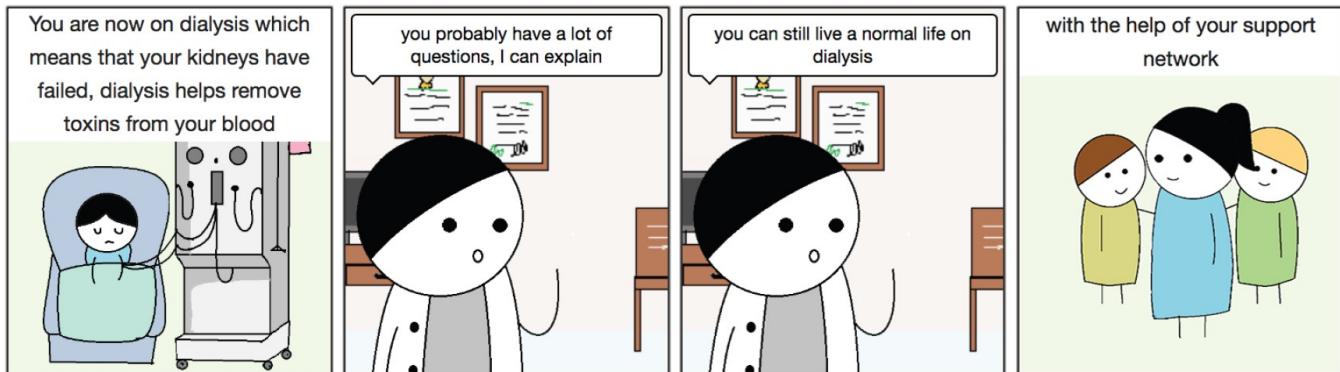


Figure 1: Example panels from the Doctor Wants a Comic prototype.

ABSTRACT

Through co-design with patients undergoing hemodialysis and their healthcare professionals, we worked towards discovering how to create a personalised, welcoming, yet quick and accurate method for medical instruction communication. Exploring possibilities of meeting the widely differing goals of patients and their healthcare professionals led to designing a personalisable method for creating comics. Through ongoing discussions during the comic creation process, we explored variations in comic styles and personalisation factors such as choosing and modifying the appearance of the comic personalities, the settings, the central topics, and word usage to create the comics. Interest in using the approach that supports the creation of medical comics was high among patients and healthcare professionals. Rich feedback was obtained about information to be

included and future direction for such medical comic creation support. We reflect on lessons learned during co-design with healthcare givers and patients.

CCS CONCEPTS

- Human-centered computing → HCI design and evaluation methods; Participatory design; Interface design prototyping.

KEYWORDS

health communication, medical comics, storytelling, visual thinking, co-design, graphic medicine

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1 INTRODUCTION

Navigating the complexities of physician-patient communication presents a multifaceted challenge, particularly as patients need to remember and practice adherence to the medical instructions they receive to achieve positive treatment outcomes. This challenge is notably magnified for patients suffering from rare conditions or embarking on a treatment for a severe and/or long-term illness,

where the necessary information can be extensive and overwhelming [28, 34]. Physicians amidst their busy and demanding work schedules, must deliver the required information within the limited time available to them. Physicians are extremely cognisant of the importance of this communication on the long-term health of their patients. Many approaches are being tried to improve this communication from engaging professional designers and communicators, to presenting medical instructions and patient stories in different formats such as pictographs [23], illustrations [5] and comics [1, 3, 22].

However, these typically lack the precision of medical instructions because they are created as general instructions for patients undergoing hemodialysis (i.e., dialysis, a life-sustaining treatment for removing waste and excess fluid when kidneys are no longer able to function properly [39, 63]). These carefully designed communications are commonly relying on extensive verbal or written explanations that may not address a patient's unique needs. Therefore, the gap in communication between patients and their healthcare professionals remains a significant challenge. The ability for patients to share their experiences or learn from others in similar situations proves beneficial, and offering emotional support and practical advice in dealing with their illness on a day-to-day basis.

To tackle the communication challenges in conveying complex medical information, and inspired by the benefits of co-design documented in existing research to improve healthcare services and empower patients [29, 65, 75], we initiated a co-design collaboration with physicians, healthcare workers, and patients, focusing on the design and creation method of personalised medical comics. This initiative, initially raised by a nephrologist (i.e., kidney doctor) and his team, aimed to make medical instructions and patient experiences accessible and engaging through comics format, specifically for medical information and patient storytelling with goals of being customisable, easy-to-create, easy-to-read, and patient-focused for medical information and experience can be quickly and easily produced at the point of contact with patients or in the home setting.

Over 8 months, we engaged in a co-design collaboration with dialysis patients and their healthcare professionals at a local hospital, navigating a path from understanding the unique context and needs of patients and healthcare professionals, designing and testing comic styles, crafting narratives and comic with patients, and iteratively developing tool prototypes for produce such comics for them. This collaboration unfolded in a manner that differs from traditional co-design practices and the norms of study research methodology, such as employing controlled environments, questionnaires, and semi-structured interviews, given the context of our participants' lives, which are significantly shaped by their medical conditions. Undergoing regular, extensive dialysis treatments leaves them with only brief moments of feeling well, as they shared with us during the process.

We developed a prototype, Doctor Wants a Comic (DWAC), which serves as a proof of concept allowing healthcare professionals like doctors and nurses to efficiently create personalized comics within the constraints of standard consultations. To enhance usability, we introduced a user-friendly drag-and-drop interface, continually refining the process based on feedback from both healthcare professionals and patients. Our primary contributions include

the development of a tailored co-design process that improves the relevance and comprehension of medical comics for patients undergoing dialysis, and the creation of two web-based prototypes that were designed to facilitate the creation of personalized medical narratives. These innovations were designed to meet specific communication needs, and to, if deployed, make it easier and more effective for patients to engage with their health information.

Feedback from healthcare workers and patients highlighted a keen interest in utilizing comics for delivering medical instructions and enabling self-reporting. This underscores the necessity of striking a balance between the customisation flexibility of manual creation and the efficiency of automated assistance in the comic creation process. Such insights open avenues to enhance health-related communication across the healthcare spectrum by introducing medical comics more widely and developing a comic-making tool with a resource library tailored for individuals with complex medical conditions.

2 RELATED WORK

Comics are a popular form of storytelling in visual narrative, and also can cross disciplines, language and culture barriers, and support work in a variety of contexts: they are no longer simply to provide "escape and entertainment" [76]. During the Covid-19 pandemic, comics are used successfully in science communication, conveying textbook jargon such as "social distance" and "flattening the curve" as a household conversation with the public in social media platforms [10, 46, 85, 105]. Comics as a method to explore and communicate complex concepts are becoming increasingly utilised in STEM subjects (i.e., Science, Technology, Engineering, and Math) [25] and especially so in medicine, where an annual conference, namely *Graphic Medicine*, is held to scrutinise these visual methodologies in research [30]. Within Human-Computer Interaction (HCI), comics are common in user scenarios [31, 35, 37, 95], and research dissemination [53, 71, 78, 79], but whilst some attention has been given to automating comics generation [6, 49], there is little literature on creating digital comics for medical information. To situate our work, first, we examine the recent field of graphic medicine, to establish the current context for comics in the medical setting; then we look at how comics have already been utilised in HCI research, before providing an overview of current comics authoring options.

2.1 Graphic Medicine

Graphic medicine utilises comics and other visual methods to document, inform, and communicate the complexities of medicine and patient experiences [34], offering a valuable resource through graphic novels created by those affected by illness or working in healthcare [14, 20, 99]. This approach addresses communication gaps between healthcare professionals and patients, particularly with serious diagnoses, by promoting empathy and mutual understanding [30, 34]. From the patient's or caregiver's perspective, however, comics depicting lived experience are usually self-created (e.g. [2, 26, 69]), and developing and publishing a graphic novel or even a short vignette is beyond the scope of most of the chronically

ill. Graphic medicine also works the other way around too, by visualising medical information, doctors are able to reduce a complex diagnosis to a few simple panels [34].

Research extensively documents the effectiveness of comics in medical communication, showing they enhance healthcare workers' clinical, teamwork, and communication skills [36, 44], improve patient comprehension and memory of instructions [5, 64], and offer social support by connecting patients with shared experiences [3, 17, 27]. Comics have proven especially beneficial for groups with lower literacy and children, making complex medical information accessible [18, 41, 47]. Visual strategies have been shown to be preferred and can improve patient knowledge when compared to written information [47, 67], or as a movement to intervene with the dominant narrative of treating dementia care as a burden [90]. Patient-centred development is also found important when looking at graphic medicine [21, 40]. Comics also support informed consent processes [12, 28], presenting a digestible alternative to extensive explanations, and hold the potential to enrich medical education and empathy [33, 54, 61, 84]. The growing focus on graphic medicine's design aspects, including the illustration of temporality [92], metaphors [91], layout [98], and co-creation between artists and researchers [86], indicates its expanding role in enhancing scientific understanding and health promotion.

Despite this broad range of research in comics and medicine, however, it has been suggested that the “full potential of comics in health settings is not being realised” [62], so by exploring graphic medicine, we aspire to establish a novel communication method within clinical settings. Moreover, the visual methods need to be carefully developed and validated with both the targeted patient population and the clinical experts [93]. Our approach is grounded in, and tailored toward, the real-world experiences and needs of those directly involved.

2.2 The Confluence of Comics and HCI

Comics in HCI, range from short vignettes in support of a theory [79], or particular viewpoints [78], to exploration of complex information in a structured manner (e.g. data comics [7, 95, 97, 107]). There are also advantages in using comics in qualitative research, both to inform and inspire those involved [24] and as a novel approach to disseminating qualitative findings to those who struggle to actively engage [38]. Scott McCloud’s Google Chrome comic [60] displayed complex technical information on a new browser for a novice audience, and this ability of comics to cross over the divide from technical documentation to highly readable matter is also helping novices learn programming [83], understand personal data [31], concepts in privacy and security [53, 81, 104]. HCI is an interdisciplinary field, in which collaboration is a common working model, comics are used as a heuristic tool and narrative approach from the initial ideation phase to the delivery phase [58, 80], and creation activities are frequently used for engagement with collaborators and participants [51, 52, 94]. Based on a co-design approach, we present a patient-centred process of creating medical comics and providing authoring applications to move towards better patient and practitioner creation support.

2.3 Authoring Comics with Tools

The widespread appeal of comics has spurred the development of applications enabling users to quickly and easily create their own comics, ranging from simple drag-and-drop interfaces [6, 42, 88, 100], design patterns for varied narrative goals [8, 81, 82], assistive sketching [55, 106], generating panels from previous content or other formats [16, 48, 59, 72], automating layout [15], avatars speech bubble placement [19, 48, 73], and to enabling interactions [87, 96].

In specialized fields like healthcare, the creation of personalised comics that convey technical or personal data, such as medical instructions or patient data histories, remains challenging. Current tools often lack the ability to customise or include specific context-related information, like medical equipment. While some applications quickly adapt user-generated text to avatars (e.g., [48, 73]), they fall short in providing relevant context. Despite the recognised value of graphic medicine in patient storytelling and education, the detailed exploration of medical comic creation as a self-authoring tool for enhanced communication among doctors, healthcare workers, and patients has yet to be fully addressed.

2.4 Patient-Centred Co-Design

Research co-design in healthcare, as outlined by Slattery et al.[75], engages consumers, clinicians, and other stakeholders in the study planning phase, ensuring their roles are clearly defined and integral to health research. This method has proven benefits, such as service improvement [29, 75] and empowerment of underprivileged groups [65]. Bate and Robert [9] and Steen et al. [77] emphasize the importance of incorporating diverse perspectives to align healthcare services with user needs, promoting more genuinely user-centred care. Such co-design must be adapted to specific contexts, particularly when involving participants with conditions like aphasia [101], depression [45], or the elderly [50]. In our research, we recognize the need for highly personalized and detailed information for patients with Polycystic Kidney Disease (PKD), due to the complexity and variability of the condition. This necessitates a tailored co-design approach that addresses the significant daily impacts of the illness and meets the diverse needs of PKD patients, thereby enhancing the effectiveness of the medical comics.

3 CO-CREATING MEDICAL COMICS WITH PATIENTS AND HEALTHCARE PROFESSIONALS

This section begins by presenting our overall methodology, followed by detailed descriptions of the participants (i.e., the *patient interest group*) and our design goals. Figure 2 visually outlines the 11 stages (A-K) of our research process, with each stage influencing the subsequent one.

The Health Research Ethics Board at the University of Calgary approved the study (REB16-2115). We were allowed to attend the patient interest group (Section 3.2) and could conduct our study if all present in the group that day consented. All participants were informed about the study's purpose, their role in it, and the voluntary nature of their participation. They provided written consent prior to participation. We ensured all participant data were handled and stored according to the ethical guidelines set forth by the approving REB. We did not collect demographic information.

We began by conducting a series of discussions with healthcare professionals to gain a deeper understanding of the challenges faced by dialysis patients and to create a plan for the co-design process (Section 3.1). To initiate a dialogue with the patient and investigate the suitability of comic styles for our target audience, we created a medical comic with four distinct styles. These were subsequently tested with the patient interest group (Section 4). To provide a more relatable experience for the audience, we worked closely with one patient to develop a narrative of their experience undergoing dialysis (Section 5). After obtaining feedback on the comic from the patient interest group (Section 5.1). We then developed a web application prototype specifically for healthcare professionals (Section 6), which was then validated through feedback from the healthcare professionals (Section 6.1). To further improve the accessibility of the approach for patients, we made necessary changes to a version for patients, and discussed the prototype with HCI experts (Section 7). We presented it to the patient interest group for final feedback (Section 7.1) During each session, we documented participants' feedback by hand notes and provided pens for them to annotate directly on the printed comics.

This collaboration between groups of HCI researchers, healthcare professionals, and patients is committed to exploring how to improve medical care from a patient-centred perspective. The HCI team is 4 people with HCI skills focused particularly on co-design, sketch-based design, visualisation, and comic creation. The healthcare professionals are part of a larger group of medical researchers associated with a local hospital, most of whom are actively practising doctors, other caregivers such as nurses, and medical researchers. The group of patients is part of a patient support and patient research group who were interested in contributing to discussion leading toward improvements in care - even if that was for the future and might not directly change things for themselves.

3.1 Initial Discussions with Healthcare Professionals



To understand the communication challenges faced by patients undergoing dialysis, a series of discussions were organised with their healthcare professionals who are responsible for taking care of them (Figure 2 (A)). The conventional hemodialysis regimen, serving as a substitute for the kidney's filtering function, is three sessions per week, each ranging from 8 to 12 hours [39]. Every hemodialysis patient harbours the hope for a kidney transplant, as it holds the potential to significantly enhance their quality of life. Yet, the likelihood of this occurring diminishes with age. One patient in the group had been on dialysis for close to 30 years, which is rare but also makes them an unlikely candidate for transplant. All members of the group were very aware of how precious the rare moments during which they felt relatively good. The healthcare professionals cautioned us against presuming that we (i.e., the HCI researchers) could dictate the conversation's direction. This meant deviating from traditional HCI studies and interviews where researchers typically frame the process around a specific topic or follow a predefined protocol. Instead, we adopted a more passive

stance, immersing ourselves in their conversations and allowing the patients' interests to steer the discourse. We employed a method that was exploratory and discovery-oriented, devoid of rigid structures, preset questions, or analytical frameworks.

The healthcare professionals noted that patients face several difficulties during their transition to dialysis, including anxiety, depression, adapting to lifestyle changes, and comprehending their new medical condition. These challenges were seen as significant barriers to patients' overall quality of life and their ability to successfully manage their dialysis treatment. Empathizing with the overwhelming adjustments patients face with dialysis, the doctors were actively engaged in various initiatives aimed at improving communication with patients and were intrigued by the potential of using comic narratives as a means of promoting patient engagement and understanding. In particular, the discussions (Figure 2 (A)) highlighted the current challenge indicating that the dominant text-based information is overwhelming, technical, and not individualised. With the enthusiasm of the healthcare professionals, we obtained permission to work with a local dialysis patient interest group. We aimed to co-design dialysis comics with them, creating resources tailored for current patients and those who may require dialysis in the future. At a high-level plan to produce stylistically accessible dialysis comics through an iterative co-design process engaging patients and healthcare professionals. This collaborative effort aimed to: 1) Appropriate comic styles for medical information; 2) Developing an authentic and resonant comic narrative about dialysis; 3) Creating a working prototype in which the health professionals can create individualised comics in a short amount of time; and, 4) Create a comic application through which the patients can tell their own stories. Figure 2 shows a simplified diagram of the resulting process.

3.2 Patient Interest Group

The patient interest group met on a weekly basis for a variety of purposes, including casual conversation, information sharing, and mutual support. Participation in this study was voluntary and flexible, accommodating the varying health status and interests of the patients. No formal recruitment was carried out and only those who expressed interest in participating were requested to sign a consent form and provide participant information. This informal and accommodating approach should be considered when evaluating the corresponding data. At a given meeting, the participants consisted of 5 to 8 patients and 2 to 5 healthcare professionals. Before the study commenced, there were no pre-existing relationships between the researchers and the participants, except for the initial consultation with the doctor, who did not participate in the patient group sessions, and no prior interactions with the healthcare professionals within the patient group. In order to maintain anonymity, the participants' demographic information was not specified. Due to the limited sample size and specific health conditions of the individuals involved, it would have been relatively simple to ascertain their identities. However, it is noted that the group was diverse in terms of factors such as gender, community of origin, and length of time on dialysis. While the patients were not often interested in answering our questions, they were interested in explaining their

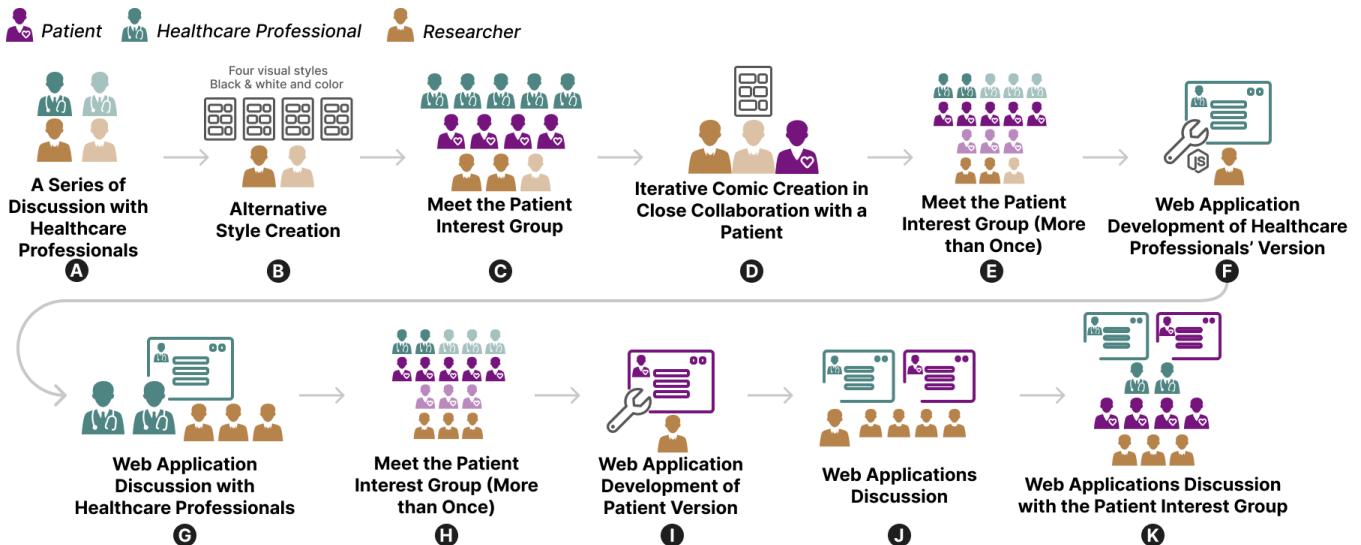


Figure 2: The step-by-step processes and methods in this project. Symbols with paler colours indicate varied numbers each time.

experiences, often infused with dark humour, and thoughtfully considered what might improve the situation for future patients.

Over several weekly sessions, we gradually increased our understanding of the lives and challenges of dialysis patients, identifying areas where improved communication could make a significant difference. HCI researchers acknowledged the unique experiences of these patients, emphasizing the importance of addressing their previously overlooked needs. Patients' active participation in discussions and design processes was vital for ensuring their needs and values were reflected in the outcomes. Patients adopted individual approaches to their involvement, contributing to the group's inductive, evolutionary nature, shaped by its purpose, participants, and the specific context of hemodialysis. The healthcare professionals advised against rushing discussions, allowing for thorough contemplation. An "open floor" approach was implemented to allow space for responses, leading to rich discussions that spanned a wide range of opinions and revisited topics from new angles.

This research, spanning about 8 months, involved creating comics and web applications in collaboration with the dialysis patients and their healthcare professionals.

3.3 Design Goals

The needs of doctors and patients include: 1) Doctors prioritise accuracy, and being able to include tailor information to individual patients and for speed of usage; 2) Patients desire materials that are approachable, non-intimidating material, with a focus on ease of understanding.

Our design goals, shaped by initial discussions with healthcare professionals, centred on creating medical comics that cater specifically to the unique context of patient care. We set out without a fixed vision for the final product, opting instead for a flexible approach that would evolve through testing and feedback from the patient interest group. These goals include:

G1—Customisable Comics: Tailoring each comic to the individual patient's situation to ensure relevance and effectiveness in communication, thereby minimizing reading time and providing specific medical instructions.

G2—Easy-to-Use/Create: Recognizing healthcare professionals' time constraints, our objective is to offer a straightforward, low-learning-curve method for quickly creating medical comics.

G3—Easy-to-Read/Understand: We aim to produce comics that convey information clearly and simply, making them easily understandable for dialysis patients.

G4—Visually Appealing: Our designs strive for visuals that capture attention, facilitate engagement, and provide positive emotional support to patients.

G5—Patient Focused: The comics, whether created by healthcare professionals or patients themselves, are intended to enhance patient care by focusing on the patients' needs and experiences within medical communication.

These design goals will be referred to throughout the following sections, guiding our decisions and adaptations based on new insights and feedback from ongoing engagement with the patient interest group.

4 COMIC STYLE

Four visual styles
Black & white and color



Alternative Style Creation

B

The selection of a visual style plays a crucial role in enhancing the appeal and effectiveness of communication. To identify the graphic styles and aesthetic elements preferred by patients, we embarked on a study involving the creation of sample comics (G4), and introducing the concept of medical comics to the patient interest group. Using reference material on levels of abstraction [57] and style [56], we developed four sample comics ranging from simple (stick-man, similar to XKCD style [66]) to detailed-stylistic (similar to Roy

Lichenstein style of art [11]) (Figure 3). We aim for the reusability of the character illustration and to learn about how abstract style can allow people to apply these character illustrations as avatars of themselves by making simple changes to the characters (e.g., the style of hair) (G1, G2). Both black-and-white and colour versions of the comics were produced to gauge any preference. The narrative content for these comics was derived from standard patient instruction leaflets for a widely used medication (the antibiotic tetracycline), focusing on instructions and side effects. This early stage deliberately avoided dialysis-related content to centre the feedback on the feasibility of the method and the comic styles rather than on content specifics.

4.1 Comic Style: Feedback



Meet the Patient Interest Group

With both the healthcare professionals and the patient group, we discussed choices of styles for engaging in communication with medical comics (G4) (Figure 2 (C)). In response to patient feedback indicating a preference against being referred to by participant IDs like “P1” and “P2”, this paper will avoid quoting them using such identifiers. The overall preference in style was for an “enhanced stickman” (illustrated in Figure 3; left side the 2nd row and the right side) favoured for its readability and ease of understanding. The more detailed style ranked as the second most preferred choice. Concerns were raised by two patients about whether the cartoonish style adequately conveyed the seriousness of medical conditions or side effects – “too cartoonish people have tendency to not take seriously.” Conversely, another patient found the comic style “joyful”, appreciating the positive connotations linked to childhood memories of reading and watching cartoons. One patient referenced the comic strip *Archie* [68] as evoking pleasant childhood memories, highlighting a consensus among some participants that amidst the negative connotations linked with beginning hemodialysis, a lighter, more approachable comic style could offer therapeutic benefits. Opinions were split regarding the preference for colour versus black and white illustrations, with patients favouring colour for its “less stressful” readability and cohesive visual impact. However, a nurse participant pointed out the rarity of colour printers in hospital settings, suggesting that designs should be optimised for clarity in black and white to ensure accessibility. Therefore, we chose to use a plain colour scheme with striking contrast, and dark outlines. In addition, it was suggested that incorporating such comics could effectively complement the extensive, text-heavy patient information materials currently provided, offering a more digestible format for conveying medical information.

5 CONTENT AND DIALYSIS STORY DEVELOPMENT



Due to the limited number of patients available and the significant demands on their time due to treatment and severe health conditions, we engaged a volunteer patient who was willing and able to provide an in-depth review. In the initial stages of story development, we worked closely with this volunteer

patient to develop a narrative and symptom list for those starting unplanned dialysis (Figure 2 (D)). Drawing from their personal experiences and the medical information they had access to, the volunteer helped pinpoint the most relevant and informative aspects of the dialysis experience to be featured in the story. This collaboration led to the creation of an additional example comic (shown in Figure 4), designed to set realistic expectations for new dialysis patients. Based on the initial feedback obtained about style (Figure 2 (C)), the selected style for this comic was intentionally simple yet more nuanced and substantial in its depiction of figures compared to the earlier enhanced stick figure approach. The narrative was organised into clearly differentiated sections, each highlighted in a yellow box with headings like “what to expect” or “symptoms” to ensure easy navigation through the content.

5.1 Content and Dialysis Story Development: Feedback



Meet the Patient Interest Group (More than Once)

E

To gather feedback, printed copies of the comic were distributed to participants during a patient group session (Figure 2 (E)), prompting them to share their immediate verbal reactions and engage in a discussion about the comic’s content. This feedback is largely from discussions in the patient interest group and some from caregiver discussions, which was essential for confirming that the comic’s message was clear, empathetic, and relevant to the experiences of those undergoing unplanned dialysis. Insights gained from this session were subsequently integrated into the prototype for the medical comic creation tool.

Comic Length & Layout: The readability of the comics is significantly influenced by their length and layout, addressing our goals for easy-to-read, visually appealing, and patient-focused content (G3, G4, G5). Traditionally, information for new dialysis patients is presented in a large letter-sized folder, which patients often overlook due to the overwhelming volume of information received at the onset of treatment. Patients had suggested that they have tended to ignore it until the side effects become a problem, so the potential for the dialysis comic to quickly summarise the relevant information was an exciting prospect, potentially mitigating issues for new patients. Feedback on the comic’s length indicated a preference for simple and concise content, with one patient noting, “Something short and sweet like this is beneficial as it isn’t overwhelming”. Discussions also highlighted the potential to expand the initial two-page comic through additional modules. Additionally, another patient suggested that the shorter format is especially suitable for new patients, stating, “I knew I was going on dialysis, this is not for me, this is for new patients. Don’t get carried away with combining everything.” Feedback on the layout was sparse; however, one participant suggested improving the spacing of the yellow “title” panels to avoid clustering in the narrative. This adjustment, while ensuring information remains well-organised and distinct, was also noted for its effectiveness in segmenting the content for clarity.

Characters & Relatability: Feedback from the group indicated that precise resemblance to the reader was not deemed crucial for the overall impact of the comic, though all participants found the

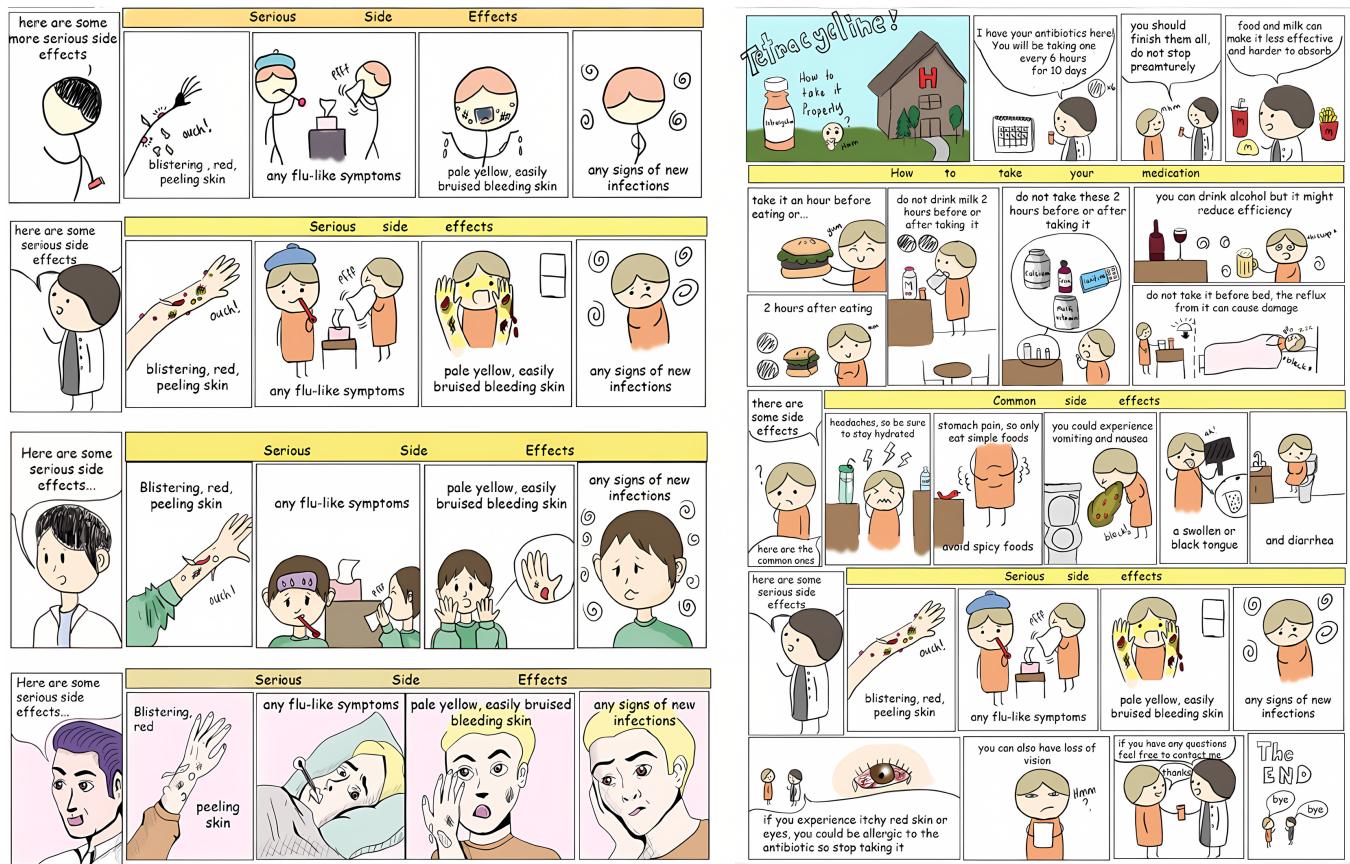


Figure 3: Left: This shows different comic styles telling the story of the antibiotic tetracycline's side effects, one row of the four comics created in alternative styles, varying in level of detail from enhanced stick figure to semi-realism from top to down. Right: a 'simple' style of the full comic illustrating how to take the drug and its side effects in an enhanced stick figure style.

characters to be relatable, aligning with our goals for customisability and patient-focus (G1, G5). The simplicity of the characters was seen to be a positive factor, in avoiding issues with race and gender, as this approach sidesteps potential sensitivities related to race and gender. Nonetheless, the importance of facial expressions was highlighted to prevent characters from appearing "creepy". A specific concern was raised regarding the "doctor" character, as the patients felt that doctors would not necessarily have time to use the system at the point of care, therefore there should be an option for a social worker or nurse, who would not necessarily wear a white coat. This feedback underscores the need for flexibility in character representation to better mirror the diverse healthcare settings and professionals involved in patient care.

Use of Language & Imagery: The discussion around language highlighted concerns with understandability, due to the technical nature of current medical communications, and generalisability, assessing its broad applicability (G3, G5). Simplifying terminology was emphasised by a nurse, particularly for patients with literacy challenges, who may struggle with medical jargon like "reflux". The conversation also touched on the portrayal of family support, recognizing that not all patients have access to family support, and some lack any form of support at all. The term "support network"

or "those close to you" was recommended for inclusivity, as shown in Figure 1.

A major point raised was to avoid the use of leading statements such as "you should be able to..." as this puts unnecessary pressure on patients who may have varying levels of activity or ability to conform to arbitrary expectations. "(The word should) make[s] you feel guilty when you can't." As the language used in the final web-based prototype is the choice of the end-user, it is possible to conclude that some prompting or *language advice* would be useful in the application's "Help" section. The addition of a *translation* or *other language versions* of the application was proposed to extend the comic's accessibility.

Feedback on imagery stressed the need for clear representation, with specific calls for adjusting the style for clarity. In particular, patients felt the blood pressure monitor was unclear as it was on a stick man's arm – although stylistically consistent, it was felt that the style should be adjusted to better communicate the device. The dialysis machine itself (Figure 4, left) was well received, but extra detail was suggested – to show the *different colour of blood* going entering and leaving the machine, which could help put patients at ease if they were not expecting it. As many patients on hemodialysis are typically more senior in age, for the leisure

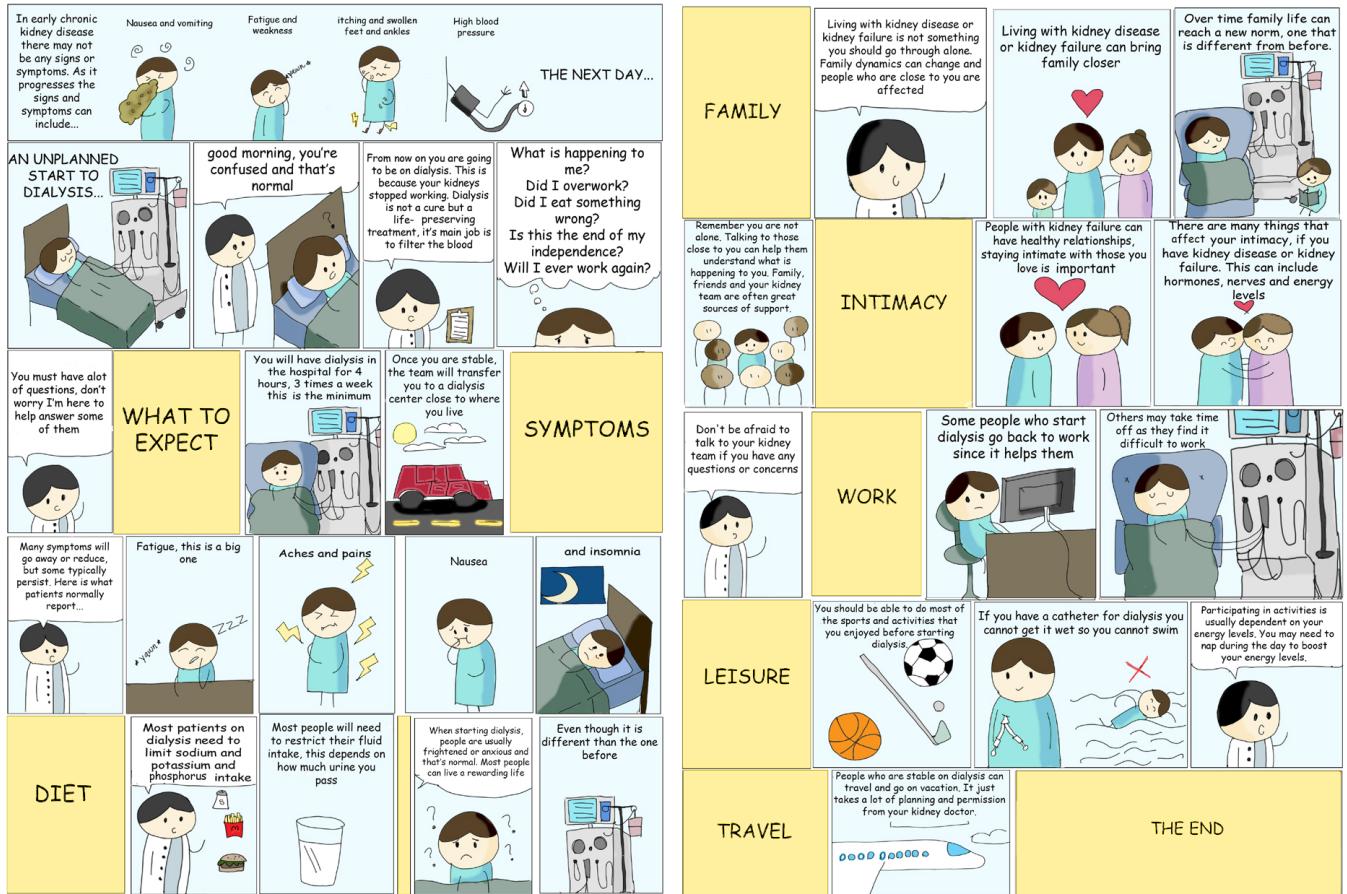


Figure 4: Collaborating closely with a volunteer patient, we crafted a comic that tells patients what to expect when starting dialysis.

section there was unanimous agreement that only a small minority of patients are likely to be fit enough to play physically active sports such as hockey or football. Kidney failure and hemodialysis often lead to extreme fatigue; therefore, low-impact activities like *walking and gardening* are recommended as alternatives.

Content: To provide content that reflects on their real-life story (**G1, G5**), there were many high-level discussions regarding patients' lived experience with dialysis, some of whom had been having the procedure for over 15 years. The intention behind the comic narrative was to convey the realities of living with dialysis while infusing a positive outlook, such as highlighting the potential for closer relationships with loved ones or the ability to travel.

However, this approach raised concerns about possibly "sugar-coating" the harsh realities many patients face in maintaining daily life activities. One patient shared the personal struggle of merely trying to meet friends for coffee or lunch, which ultimately led to losing friendships over time. This feedback underscored the delicate balance needed in storytelling, between offering hope and not underplaying the challenges encountered. The counter-argument to this perspective is that this kind of information is not helpful to those newly facing dialysis, and the comic would be better focused

on suggesting *help networks* and emphasising that the patient is not alone – negatives cannot be predicted and may be counterproductive at the point of care.

Concept: Feedback from the patient interest group on the concept of employing comics for medical communication underscored concerns about the limited time doctors have during patient consultations. Patients doubted the feasibility of doctors dedicating even 5 to 10 minutes to create comics, given their tight schedules. Conversely, they posited that nurses might have more interaction time with patients. A healthcare researcher highlighted the need to motivate doctors to adopt new approaches, which could be a focal point during the implementation phase. The idea of streamlining the creation process, *text-to-comic*, was particularly well-received among those who felt they lacked artistic skills even with *drag-and-drop*, as one put it, "Not many of us are graphic designers in our spare time!" Healthcare professionals also emphasized the importance of presenting the comic in printed form, noting that "when patients in hospital have no access to computers, [...] the last thing they (patients) want at hospital is to say go online".

6 WEB-BASED PROTOTYPE #1: HEALTHCARE PROFESSIONALS' PERSPECTIVE



Drawing upon comic style feedback, our concept, content, and storytelling feedback, the initial request from doctors, and our design goals, we developed a prototype, Doctor Wants a Comic as proof of concept (Figure 2 (F)). Inspired by the Leann Startup Model [70] to construct a Minimum Viable Product (MVP), employing an agile approach that guides the conception to a working product that enables the HCI researcher to assess the hypotheses and eliminate incorrect assumptions quickly.

The prototype was developed in JavaScript for cross-platform compatibility. Creator inputs are stored in a 2D array corresponding to the number of panels in the comic. Characters, including doctors and patients, can be easily placed within these panels and adjusted as necessary. Customisation options allow for the selection of multiple character versions (including non-binary) with different attributes from a visual list, such as hairstyle or clothing, enhancing relatability and inclusivity (G1).

To streamline the creation process and minimise the workload (G2), *speech bubbles* are automatically positioned within the panels, eliminating the need for manual drag-and-drop. Based on the initial feedback from healthcare professionals and the patient interest group (Figure 2 (G)), we integrated a “Download” button for easy printing or saving of the comics. The option to reload and modify previous comics for new patients was introduced to further save time (G2). Additionally, a straightforward “*how-to*” guide accessible from the main page ensures creators can easily understand and use the tool without needing to recall complex steps (G2), complemented by in-line prompts within the comic creator interface to further ease the creation process (e.g. using a double space to start a new panel).

Using the Prototype: To use the application, the creator opens the application in the web browser, and is taken to the landing page (see Figure 5). On the landing page, they can select how the characters, i.e., doctor and patient look for relatability, once they are happy with their selection, they can move on to the second page where the text-to-comic editor is hosted. To represent the doctor as the person who is speaking, the user types a single dash (-) as the starting character and indicates that the patient is speaking the equals sign (=) is used. No starting character indicates a text panel. The input is divided into i) instructions (how to take the medicine or instructions about other medical interventions), ii) side effects (e.g., what might happen whilst on the medicine/medical intervention), and iii) an additional section for other information that the caregiver thinks is important. When the user presses “ADD”, the comic appears in the space below and can be further edited before downloading for print.

6.1 Healthcare Professionals' Perspective Feedback

The prototype link was shared with two medical professionals—a nurse practitioner and a medical doctor specializing in kidney services—for feedback (as depicted in Figure 2 (G)).

DOCTOR WANTS A COMIC

Doctor's name? Doctor Two

Patient's Gender? Other

Patient's Hair Colour? Brown

Doctor Preview Patient Preview

NEXT ?

TEXT FOR THE COMIC

Doctor Patient

*** Keywords you can use currently: nausea, bleeding, blistering, headaches, fatigue, insomnia, dialysis, family, relationships, catheter, aches and work (exactly how they're spelled here)**

Comic Title
title your comic

How do you take the medicine?
Enter Text Here! start with '-' for the doctor or with '=' for the patient.. double space means a new panel. If you want both people add '-' or '=' for the person to appear

What are the side effects?
Enter Text Here! start with '-' for the doctor or with '=' for the patient.. double space means a new panel

Anything else? (Leave this blank if there isn't anything)
title

ADD SAVE LOAD CLEAR DOWNLOAD BACK

Figure 5: Web application landing page and text entry page. The top of the image shows how a creator can choose the appearance of the doctor and patient, the lower image shows a text entry interface that has greyed-out suggestions of how to use the application and tells a creator to add a title, text, and also a “save” option.



Web Application Discussion with Healthcare Professionals

G

They provided their insights by recording their overall impressions and specific feedback on the prototype. The reception was notably positive; both professionals appreciated the innovative concept and the visually appealing output of the application. They recognised the significant potential for future development and application.

within the medical field. Particularly, they were intrigued by the idea of instantly creating time-saving, personalised graphics.

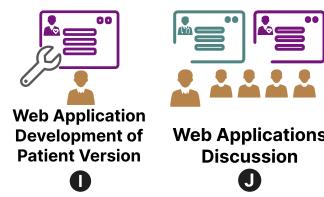


Practical Advice for Future Updates: Feedback from the patient interest group (Figure 2 (H)) offered actionable suggestions for enhancing the Doctor Wants a Comic prototype's functionality and user experience: The terminology used for *symptom keywords*, perceived as “too medical”, should be made more accessible. Terms like “nausea” and “fatigue” could be replaced with “feeling sick” and “tiredness” to ensure comprehensibility for all users. Implementing a *dropdown menu for symptoms* that auto-populates text boxes could streamline the creation process. Additionally, including default advice or symptom management tips that automatically add to the comic panels would save time, with the option for further customisation to address individual patient needs. Offering “off-the-shelf” comic examples for new users could serve as both inspiration and a time-saving template, allowing users to modify these templates according to their needs. In its current form, Doctor Wants a Comic is accessible only through standard desktop and laptop web browsers. The suggestion was made to expand availability to *tablet and mobile devices*, as this could increase uptake if the application were to be rolled out to a wider user group. Incorporating *voice commands* could enhance accessibility and efficiency, particularly in clinical settings where hands-free operation might be preferred during patient consultations.

User Groups & Use Cases: There was recognition of the broad potential application of the comic creation approach within the medical field. However, practical considerations at this early stage of development suggested focusing on outpatient settings for chronic illnesses. In such settings, the need to convey extensive information efficiently is paramount. The comics could serve to reinforce and supplement discussions between doctors and patients, offering additional insights into various conditions or treatments that might not be thoroughly covered during consultations. The prototype was also seen to have the potential in other medical scenarios. For example, to provide information before treatments, procedures, or clinical appointments, to help patients self-manage their condition and make decisions about their treatment options (i.e. explaining risks/benefits). It was also seen to help families or healthcare professionals better support their family members or patients. From a clinical standpoint, the tool holds promise for a wide array of healthcare professionals beyond kidney services, one nurse from the healthcare team noted, “This could be great for kinesiologists and nutrition teams – exercise, wellness, even social work. This model could be very good. Red light green light food example – people can use to navigate food choices”, highlighting the potential multidisciplinary application of our model in real-world settings.

7 WEB-BASED PROTOTYPE #2 PATIENT STORY TELLING

For patient storytelling, our development emphasised a user-friendly prototype offering creative flexibility, focusing less on rapid generation and more on a tailored experience.



To meet this goal, we designed a second prototype with a visual editor, informed by existing comic creation tools like Pixton [32], Storyboard Creator [74], SAGE [89], and iCOMIC [42], blending their features to create an interface suitable for medical narratives. Pixton is aimed at professionals, and the latter two are designed for children, we felt that combining the approaches would enable us to make an accessible interface. We developed the prototype #2 and then tested it with fellow HCI researchers (Figure 2 (J)), before being demonstrated to the patient interest group.

We adapted the original interface to better suit patient needs (G5), linking emotions to *keywords* and maintaining a baseline of neutral expressions. This version upheld the same input methodology, including syntactic commands for character variations and narrative triggers. Enhanced user guidance through a *help* menu and added *error handling*, such as textbox highlighting for format mistakes. Popular functions like “*save*” and “*load*” were preserved.

A subsequent iteration introduced a drag-and-drop interface, enriched with pictorial elements representing *emotions*, *situations*, and *characters*. This version allowed users to add or remove panels via buttons and included a “*toolbox*” for selecting characters and emotions and then dragging them into a holding area before being placed onto panels. *Speech bubbles* were generated by entering text and selecting from three styles (i.e., talking, narration, and title text), making the process more intuitive and visually oriented. Both versions underwent testing with HCI researchers before being presented to the patient interest group, ensuring the approach aligned with patient storytelling requirements.

7.1 Patient Story Telling Feedback



This time the patient interest group consisted of four dialysis patients and two healthcare professionals (Figure 2 (K)), was introduced to two storytelling interfaces. After a demonstration, participants freely explored the applications (Figure 6). The participants are often overwhelmed by new things as they have limited capacity and are often extremely tired and in a lot of pain. We did not push them to try the application and instead chatted more generally, but interest spiked when one patient began using the application, remarking on its fun and easy-to-use nature. This prompted others to participate. Feedback was then collected on usability, preferences, and potential improvements.

Potential for Adoption: While the drag-and-drop interface was appreciated for its intuitive design, patients lacking access to tablet computers reported difficulties using a trackpad or mouse. Patients found the time investment for drag-and-drop creation too long, suggesting it would be best suited for those with artistic ability and a passion for the process. Conversely, the text-based interface, initially daunting and likened to coding, was ultimately seen as enjoyable and quicker once mastered, especially for blog creation.



Figure 6: A comic made by a dialysis patient using the platform originally made for doctor-patient communication.

Its keyword feature for explaining medical terms and customizing characters was universally appreciated, as it could be used to explain diagnoses, as well as customising the characters to be “like me” – in contrast to the caregiver-focused app. Overall, patients did not strongly favour one interface over the other, valuing control but desiring the app to handle details to accommodate their energy and time limitations.

Practical Updates: To make a single interface that satisfies ease of use and time constraints (G2), the patients proposed several ideas for development. For example, a *hybrid approach* was suggested, where users initially type the comic narrative for automatic layout creation, followed by the option to directly modify panels—adjusting character placement and customisation as needed. This method ensures characters align with their intended dialogue or actions from the start, minimizing subsequent adjustments. For user guidance, another idea was introducing visual *pop-ups to correct typos* and a live *panel preview* as text is entered was recommended. To further customisation (G1), one participant suggested having the freedom to create *individual keyword libraries* relating to self-drawn or photographic images would enable unlimited personalisation of the platform.

8 DISCUSSION

8.1 Comparative Insights into Graphic Medicine

This paper tackles the prevalent challenge of communication between doctors and patients: the need for doctors to simplify intricate

diagnostic scripts and for patients to effectively relay information back to doctors. Through a co-design process that includes both patients and healthcare professionals, we developed a bespoke comic creation method tailored to the specific context of hemodialysis. Our findings underscore the value of this approach in creating personalised medical narratives and capturing authentic lived experiences. The key insights from our study include:

1) Bridging the Medical Communication Gap: At the outset of our research, we identified several key gaps in the literature concerning patient-centred and comprehensible visual aids, as discussed in Section 2. Notably, there is underexplored potential in using comics to enhance healthcare communication and address health literacy gaps [62]. Our work addresses these gaps by introducing a customisable, easy-to-use comic creation application designed to strengthen doctor-patient communication. **2) The Power of Personalised Narratives:** Tailoring medical comics to reflect individual patients’ experiences not only offers more poignant and relatable information but also fosters heightened engagement from both healthcare professionals and patients. This tailored approach helps overcome the limitations of existing graphics and pictograms in healthcare that often lack specificity for diverse patient needs due to their generalized designs. Our co-design process with patients and healthcare professionals aligns with the recommendations by Wang and Voss [93] to develop and validate visuals that meet specific patient needs and the contexts in which they are used, thereby ensuring the effectiveness and accuracy of the communicated messages. **3) Efficiency and Practicality with DWAC:** Streamlines

the creation of medical comics, directly addressing the time constraints faced by doctors and patients alike. DWAC stands out and sets it apart from prior endeavours in general comic creation tools (e.g., Clip Studio Paint [102] and Comic Life [4]) for DWAC's focus on medical relevance, incorporating keyword functionality for text-to-comic input, customisation options, and supporting formatted, printable outputs. This makes DWAC both a time-efficient solution tailored for the fast-paced medical environment and an accessible tool for patients.

Feedback from patient interest groups was crucial in refining our design to meet our goals (Section 3.3). Continuing this collaborative approach will be essential in identifying challenges and exploring opportunities for further development as we progress.

8.2 Challenges and Future Work

8.2.1 Customisation and Automation: The DWAC prototype is an initial exploration to help healthcare workers and patients create medical comics easily and quickly. There is room for potential improvement in the interface, future studies may compare a visual interface to link text to characters using symbols like “-” or “=”, and options for speech-to-text for those with difficulty typing. Our initial development utilised simple interactions and keywords to produce the comic, but the imagery and character placement could be repetitive. Current text-to-comic clients such as ComiXchat [73] are using AI to produce variation and predict panel placement, however, Comic Chat found that it was possible to “...produce interesting comics ... without any natural language processing” [48]. By incorporating a simple algorithmic approach, they were able to add interest and variation in aspects such as *zoom* and *placement*. For medical information and personal storytelling, control is essential to make sure the message produced is relevant and accurate. We propose adding panel variation functionality but without relying on user input to produce results. Another future direction is to provide some prompting or advice to aid the manual creation process, e.g., by incorporating large language models to assist in simplifying technical terms, AI-generated visual components, or suggesting layout alternatives. We note control and customisation are offset against automation in the patient condition – the challenge will be to maintain simplicity and autonomy, whilst adding functionality.

8.2.2 Crafting Patient-Focused Medical Comics –Healthcare Professionals' Roles: Healthcare Professionals have a crucial role in creating accessible medical comics and need to simplify complex medical jargon in favour of plain language to enhance patient comprehension. Training in patient communication is shifting towards clearer, more direct language use [103]. The tone of medical comics should balance accessibility with a practical outlook, optimism and, where suitable, humor, aligning with patient preferences and literature recommendations [61, 76]. The transition to digital tools like DWAC for comic creation highlights the move from handwritten to typed scripts, facilitating readability and accessibility across digital platforms. Currently, written scripts are prevalent in practice, but transmitting to digital tools promises greater efficiency in medical communication, making information more patient-friendly and easily distributable, thus addressing both the practical and emotional needs of patients effectively. This transition also enables the integration of AI assistance and multimedia content.

8.2.3 Medical Comics on Diverse Scale: The dialogue generated between creators and recipients through our process, enhanced by direct consultation with healthcare teams, underscores the advantage of our approach over traditional methods like surveys. Looking ahead, to broaden the impact and explore our methodology on a wider scale, future work could consider including consultants, hospital managers, families, and friends of patients. The exploratory nature of this study emphasised understanding the approach's potential to meet the challenges in medical communication, focusing on human aspects rather than technological advancements. The evaluation was conducted outside a controlled lab setting, reflecting the real-life conditions of the participants but limiting the rigour of formal study protocols. To further evaluate our personalised comics, we also propose to follow recommendations [40] to compare our information with existing dialysis literature, with and without images. Although several studies already address this with a focus on low-literacy groups [43], there is a need to focus on patients across a spectrum of abilities and backgrounds, ensuring our medical comics cater to a broader and more diverse patient population.

8.2.4 Immersive Co-Design in Healthcare. Our methodology reflects an immersive co-design approach, extending beyond traditional pre-design empiricism [13] to involve healthcare communities actively in shaping the research agenda, reminiscent of design by immersion principles.

Here, we present recommendations for co-designing with healthcare professionals and patients: Initiating the design process with in-depth discussions with healthcare professionals is pivotal for accurately capturing the challenges and conditions faced by patients, laying a solid foundation for meaningful research inquiries. It is essential to recognise that patients have diverse needs in different contexts. Approaching design decisions by presenting alternatives and testing patient preferences (e.g., we presented four styles for the same story and two versions of the prototype) without making pre-assumptions helped us to minimise our bias and gain more insights from discussions with patients. This also fosters creativity and encourages patients to express their ideas. 3) Ensure that patients are comfortable and respected throughout the process. Recognizing participants as insightful individuals with valuable insights and experiences rather than mere subjects ensures a respectful and engaging co-design environment. Tailoring engagement methods to their preferences facilitates valuable exchanges and underscores the importance of their perspectives in guiding the design journey. While participants showed little tolerance for extensive forms and questionnaires, they were keen to impart their knowledge and viewpoints. As researchers, our duty was to listen meticulously, endeavour to grasp their perspectives, and let their insights direct our approach.

9 CONCLUSION

We created medical comics and a comic-generating prototype “Doctor Wants a Comic” for healthcare professionals to deliver personalised, easily understandable medical instructions to patients undergoing hemodialysis. Through a collaborative design process with patients and healthcare professionals, we created imagery and storytelling to produce customised comics for hemodialysis

initiation and to share real-life experiences. This study illustrates the significance and methodology of employing co-design to enhance design outcomes and tackle communication barriers within healthcare settings. Feedback from both healthcare professionals and patients highlights the potential of the text-to-comic application in medical communication. Continued investigation in this domain could pave the way for making graphic medicine more accessible, leading to the development of an open-source online platform and image repository for widespread use.

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