Drawn Together: Merging the Worlds of Health and Comics Through Graphic Medicine

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Abstract

Although storytelling with sequential visual art has been a part of human narrative communication for centuries, interest in the intersection between the comic medium and health care has grown rapidly in recent years. Comics have an array of unique properties as a means for communication, and this expanding field of study, termed "graphic medicine," aims to better understand and employ these traits for diverse purposes in health care. Current applications of comics in medicine include education of clinicians and patients, processing of traumatic or transformational experiences in health, and raising public health awareness. Limitations persist surrounding acceptance of comics, educational impact measurement, and logistical barriers to producing content for health education, but the future holds significant potential for ongoing benefits to patients, clinicians, and academics. In this narrative review, we will provide an overview of the advantages of comics in communication, current applications of comics in health, and future challenges and directions for the field of graphic medicine.

Keywords

Graphic medicine · Comics · Health visualization · Medical humanities · Medical narrative · Medical education

1.1 Introduction

In the search for effective means to communicate and visualize health information, a growing number of medical practitioners, researchers, and educators are turning to the medium of comics, or "sequential art," as a format for engaging audiences. This burgeoning field exploring the interaction between comics and healthcare, termed "graphic medicine," aims to harness the unique attributes of comic storytelling in order to facilitate the transfer of valuable medical information, educate clinicians and patients, share experiences in illness, and engage audiences with topics important to public health (Green and Myers 2010).

The comic medium's approach to storytelling possesses a variety of distinct features with the potential to expand accessibility, engagement, and depth of communication surrounding complex topics related to health and medicine. An ever-expanding collection of graphic narrative work offers insight into diverse patient illness

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experiences while educators, scholars, and clinicians have begun delving deeper into uses of the comic medium as a means to improve healthcare. This narrative review aims to provide a broad overview of the attributes and advantages of graphic medicine as a means for education, to discuss current uses of comics in medical education and healthcare, and to highlight challenges and future areas for growth.

1.2 Terms and Definitions

A variety of terms have been used to describe the medium commonly referred to as "comics." These include but are not limited to "long-form cartooning," "picture novels," "sequential art," "graphic novels," or "graphic narratives." While each term may convey slightly different assumptions about appearance, length or style, the common feature is the combined use of words and images to convey a message or narrative in sequential order (McCloud 2017). Formats for comics have been transformed over the years by the advent of new technologies including the internet; however, storytelling using the medium of sequential art continues to hold a valuable place in communication and will likely remain a fixture even as new platforms arise (Petersen 2011; Sabin 2010). In this chapter, we will use "graphic medicine," "graphic narratives," and "comics" interchangeably to explore the current uses and capabilities of this unique medium.

Specifically, "graphic medicine" is a term coined by Dr. Ian Williams in 2007 to describe the intersection between comics and the world of health and medicine (Czerwiec et al. 2015). The term has been kept deliberately broad to include a variety of uses, including graphic memoirs, educational comics, academic papers, medical commentary, and other practices, both fiction and non-fiction; the movement toward the growth of comics and health includes a varied group of advocates, including clinicians, educators, scholars, professional artists, and lay public participants (Kasthuri and Peter 2021).

1.3 Unique Attributes of Comics as a Medium for Communication and Education

Sequential art has been a feature of human communication for many centuries, offering a variety of features that make it appealing as a route for delivering information (Earle 2021). In contrast to text-only resources, comics serve as a unique way of conveying information via "dual coding"—including the combined channels of both visual and textual information; comprehension and memory formation can be enhanced and enriched in this hybrid word-image format, as text aids interpretation of the images and vice versa (Aleixo and Sumner 2017). Although the majority of evidence regarding the impact of comics as a means for information delivery comes from small samples, numerous studies have suggested that presenting information in this multimodal format may result in improvements in learning and recall, and interest in the use of comics for education has been growing rapidly in recent decades (Noe and Levin 2020; Yang 2003).

While technology has recently made digital media such as video or audio highly accessible, comics still maintain distinct strengths compared to more passive routes for receiving information. Comics require the reader to participate in an active role in comprehension by connecting separate scenes and deducing missing parts of the narrative between image panels. This cognitive activity is given the name "closure," and it requires the reader to fill in the missing story from the limited information provided (McCloud 2017). Closure can be utilized between panels to indicate a change in time or location, compelling the audience to actively imagine these changes to continue along the story. Closure can also be prompted within an individual panel by deliberately leaving ambiguity for the reader to imagine. For example, intentionally leaving certain parts of a panel blurred or with text that is illegible enables readers to interpret what is happening in their own ways.

Even disparate images delivered in sequence can be pieced together based on one's personal experiences to create a story. For example (Fig. 1.1), three illustrated frames with images viewed in isolation (a suitcase, a plane in the air, and a man in a row of seats dreaming of the beach) that could appear unrelated are seamlessly connected by the reader, even without text, to create a narrative of preparation, travel, and destination. Because personal experience affects this process of interpretation, closure allows for different readers to have different understandings of the story despite reading the same comic. A reader from an era without air travel might struggle to make sense of the connections between the frames while most modern audiences would connect the panels with minimal effort.

The added cognitive work required to read and understand comics invites readers to play a more active role in processing and interpreting the content. For example, an observational study using an educational comic about electronic health record self-advocacy behaviors found that readers were more engaged with their healthcare and more willing to advocate for themselves when exposed to the comic (Alkureishi et al. 2021). This high level of engagement was similarly found in another study in New Zealand, where a comic "Caretoon" approach, using user-guided generation of personalized comics for an online public health survey, outperformed the equivalent text-only approach in terms of reach and diversity of audience (Kearns et al. 2021b).

In addition to increased reader engagement, the dual-coding feature of comics may also help overcome barriers of language or literacy. Even when challenges arise with text comprehension, readers can derive the arc of the story or meaning through the image-based narrative track. A growing body of research has examined the use of comics as a beneficial tool for language teaching and acquisition (Wijaya et al. 2021). In particular, studies have highlighted the advantages in vocabulary development, comprehension, and engagement for English Foreign Language (EFL) readers (Cimermanová 2015; Merc 2013). In healthcare settings, where information must be conveyed in a way that accommodates a variety of language and literacy levels, comics offer a promising avenue for delivering vital health communication between clinicians and patients.

In addition to their strengths in reader engagement, comics offer a broad and flexible palette of tools *inside* each panel, including line weight and style, text appearance, color and shading, as well as variables *outside* the panels, including page layout, sequence and panel sizes that can aid in conveying meaning, or making messages memorable (Eisner et al. 2008). In addition, the simplicity or abstraction of imagery in some comics may allow a broader population of readers to place themselves into the narrative, with deliberately reductionist characters that are not constrained to an obvious age, ethnicity, gender, or body type (McCloud 2017). Exchanging photorealistic representations for more fluid or exaggerated figures expands the range of mood and expression.

All of these strengths stemming from the structure of the medium, as well as the cognitive participation required from participants, combine to form a route for communication that is highly adaptable for a wide variety of audiences. Finally, for readers such as patients or health care students who may be inundated with text materials in coursework or educational handouts in clinical settings, comics provide a stimulating and engaging alternative for information consumption. A common finding in many studies of comics for medical education is the enthusiasm of readers for this alternative form of content delivery (Adamidis et al. 2022; Joshi et al. 2019; Park et al. 2011).

1.4 "Graphic Pathographies" as a Means for Communicating Patient Experiences

In recent decades, the practice of narrative medicine has been established as a central component of the medical humanities and describes the application of a story to medical education and practice (Charon 2001). Exposure to narrative literature has been proposed as a means of facilitating more compassionate care and interdisciplinary

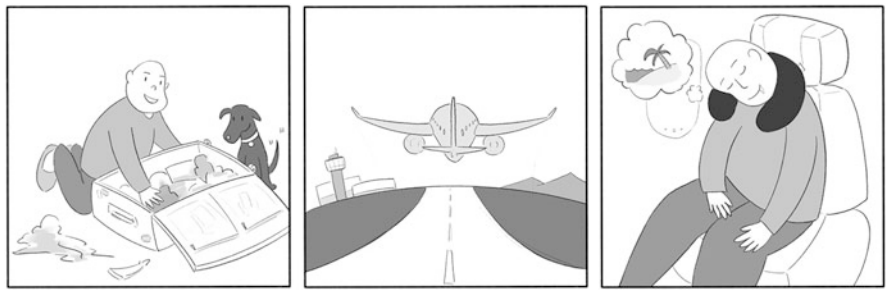

Fig. 1.1 Illustration of the concept of "closure" in which narrative is constructed from sequential images (illustration by Oscar Li). Author image

collaboration (Liao and Wang 2020). Stories can provide a broader perspective on life experiences and enhance a person's ability to empathize with others despite different lived experiences and personal beliefs (Kidd and Castano 2013).

Within this growing focus on narrative medicine, graphic medicine offers a particularly compelling format for presentation of illness narratives. "Graphic pathography" is a term coined by Green and Meyers to refer to a specific subgenre in graphic medicine that presents the patient's experience of illness in the graphic narrative form (Green and Myers 2010). Presenting illness using the medium of comics offers potential benefits both for creators and readers, as those with an illness and those adjacent exchange intimate and personal perspectives on topics as diverse as suffering, disability, and mortality. As comics are not necessarily bound by the traditional expectations and rules of prose, creating graphic pathography may allow a person to document lived experiences with health when words alone prove insufficient or too restrictive (Joshi et al. 2019). Because patient experiences are by their very nature highly individualized, every graphic pathography is also unique and deeply personal, with an idiosyncratic perspective on what medicine might otherwise reduce to a standardized list of signs or symptoms.

The individuality of style and expression can be easily seen in evaluating various graphic pathography memoirs. For example, two comic creators both chose to recount their experience receiving a diagnosis of breast cancer through comics. In "Cancer Made Me a Shallower Person" by Miriam Engelberg, the author uses simple lines in black and white, loose text, and a relaxed drawing style that may feel to some readers like peering into a diary entry (Engelberg 2006). In contrast, Marisa Acocella Marchetto also describes her breast cancer experience in her book "Cancer Vixen," but she employs bold colors, frenetic linework, and a more structured text style (Marchetto 2006). Despite describing the same diagnosis, both authors use their distinct approach to draw readers into their own varied experience of the illness.

The flexibility and freedom provided by blending words with the immediacy of artwork offers a spectrum of expression and intimacy that can be hard to achieve in other media, and use of graphic medicine in this way can intersect with some aims of art therapy, allowing for the exploration of distressing symptoms and processing illness (Czerwiec et al. 2015; Regev and Cohen-Yatziv 2018). Self-expression through creative art therapy has been suggested as a means for enhancing coping in psychiatric and psychological conditions, to improve quality of life (Chiang et al. 2019), and comic integration as a form of art therapy may be one suitable vehicle for such an intervention (Shwed 2016). While potential use of graphic medicine as a form of therapy should be guided by a trained art therapist, creating graphic pathographies still offers promising benefits for creators seeking an outlet for documenting their experiences.

Like graphic pathography creators, readers, too, may benefit from exploring graphic narratives surrounding illness and medical

treatments. Despite the individual nature of the illness experience, graphic pathographies can facilitate community-building and education through connecting individuals who share similar lived experiences (Green and Myers 2010; McNicol 2017). Readers from both medical and non-medical backgrounds could potentially benefit from exploring these windows into the lives of those living with illness, finding a path for more compassionate communication and understanding (Yu 2018). Patients who read graphic pathographies can learn about their illnesses, possibly understand their prognoses with more clarity, and maybe even mentally prepare for their next steps (Czerwiec et al. 2015).

The lens of the comic provides particularly sharp focus for daily life with physical pain or limitations. In his graphic novel, *My Degeneration*, cartoonist Peter Dunlap-Shohl tells the story of his diagnosis and coping with Parkinson's disease, sharing how neurologic symptoms' impacted not only his life, future, and function, but also his identity and work as an artist (Dunlap-Shohl 2015). In Fig. 1.2, Dunlap-Shohl describes his struggle to cope with pain and adaptation in his work as a comic artist; the frantic, quivering lines and pitchfork driven into his shoulders connect us to his experience of Parkinsonian tremors and postural pain, providing a memorable representation of his daily lived experience.

Graphic pathographies have been used to explore health experiences as varied as diabetes, Alzheimer's disease, bipolar disorder, and gender transition. In "Super Late Bloomer: My Early Days in Transition" by Julia Kaye (2018), the author uses a collection of comics surrounding her early months of gender transition as a creative way to document her experiences, thoughts, and feelings through the process. Comics have proven to be a particularly valued space for highlighting narratives of vulnerable or marginalized populations, such as the LGBTQ+ community, those living with disability, and patients suffering from chronic illness or pain (Councilor 2021; Squier and Krüger-Fürhoff 2020; Venkatesan et al. 2022; Wegner 2020). In a medical culture where the perspective of clinicians often dominates narratives surrounding health, graphic pathographies are a potent forum for recentering the story around the patient's perspective.

Although medicine is often reduced to the narrow sphere of the patient–doctor relationship, a whole team of supporters and caregivers are also affected by the illness experience. A growing subset of graphic pathographies have been created by close contacts such as family members or medical care team members to reflect on illnesses from their point of view (Sethurathinam 2018). Utilizing comics in this way allows for a more vivid representation of certain illnesses and the impact they have, not only on a patient but also the community around them.

For example, in her memoir "Aliceheimer's: Alzheimer's Through the Looking Glass," creator Dana Walrath uses illustrated vignettes to give readers a glimpse into her time caring for her mother who moved in with her after her mother's diagnosis of Alzheimer's dementia; Walrath shared that creating the book allowed her to process her grief as well as to capture and record moments from their time together (Walrath and Walrath 2016). Her work features raw sketches, handwritten text, and representations of her own mother, robed in pages cut from the book "Alice in Wonderland." In Fig. 1.3, from her graphic memoir, Walrath represents the gradual decline of her mother, explaining that she "isn't losing tangible parts, but she is disappearing," through a series of papercut figures with omitted features. Mood, movement, and mourning are conveyed in the art style and grayscale color scheme.

The engaging and intensely personal nature of first-person illness narratives through comics makes them a promising route for providing health professionals with a richer look into the lives patients lead outside the confines of the clinical space. Medical trainees who read these comics can learn more about patient experiences from their perspectives and potentially form better connections with future patients (Anderson et al. 2016; Williams 2012). As a subgenre of graphic medicine, graphic pathographies serve as powerful medical narratives capable of intimate storytelling with diverse potential applications for trainees in healthcare.

Fig. 1.2 Example image from the "graphic pathography" *My Degeneration* in which author Peter Dunlap-Shohl shares his experience with Parkinson's disease (Dunlap-Shohl 2015). Reproduced with permission

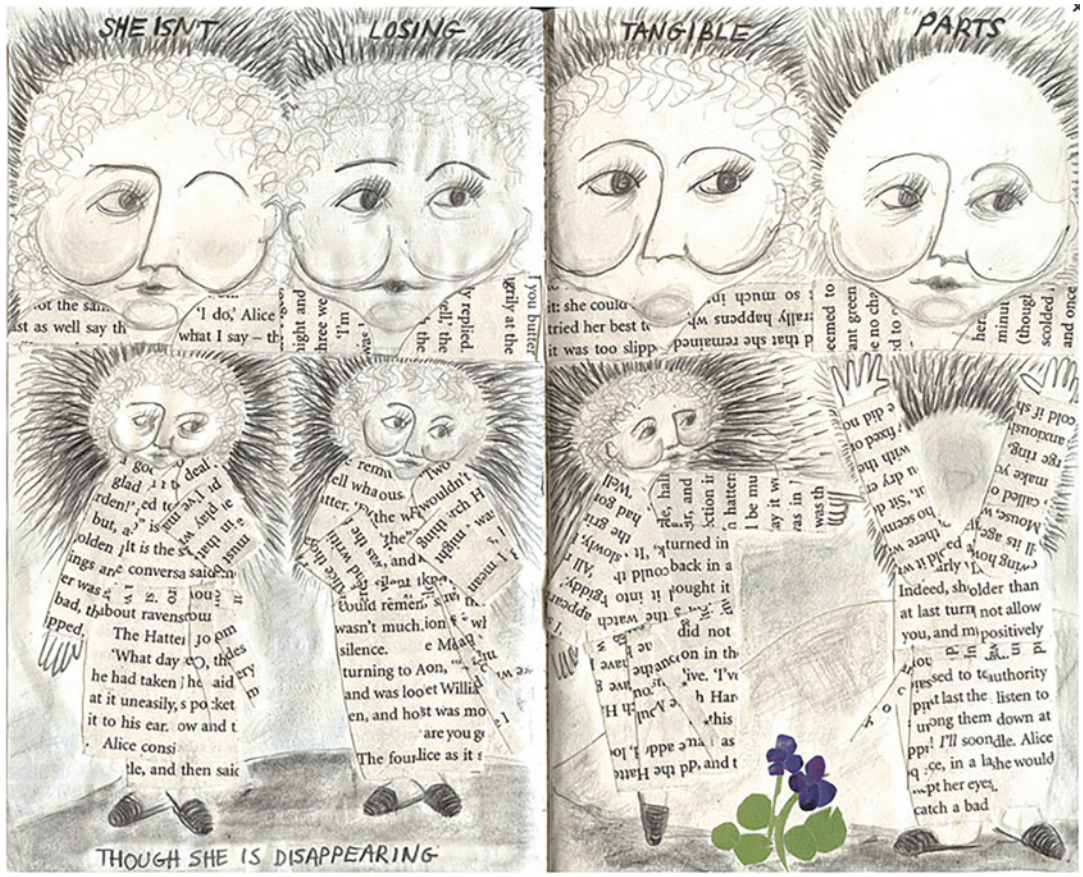

Fig. 1.3 Example image from the caregiver graphic memoir *Aliceheimer's: Alzheimer's Through the Looking Glass* by author Dana Walrath (Walrath and Walrath 2016). Reproduced with permission

1.5 Graphic Medicine in Undergraduate Medical Education

Medical schools throughout the world have integrated the humanities into their undergraduate medical curriculum through studies of medical ethics, literature, and the arts. A study in 2017 found that 70.8% of medical schools offered required humanities courses with each student completing 43.9 h on average (Klugman 2018). While the evidence base for many of these initiatives driving humanities is still in early development, graphic medicine offers a vibrant avenue for delivering such content and a ripe field for study of its impact. It has been suggested that studying the medical humanities may allow medical students to build upon multiple skills including better communication, cultural flexibility, professionalism, and self-reflection, although additional study is needed to prove its effect (Ousager and Johannessen 2010). Shapiro and colleagues describe the potential for medical humanities in enhancing students' "observational and pattern recognition skills" (Shapiro et al. 2006). To medical students, the study of medical humanities is also generally perceived as valuable, with younger students highlighting the need to keep an open-minded perspective of medicine during the pre-clinical years and older students stating the desire for a break from intense clinical education (Petrou et al. 2021).

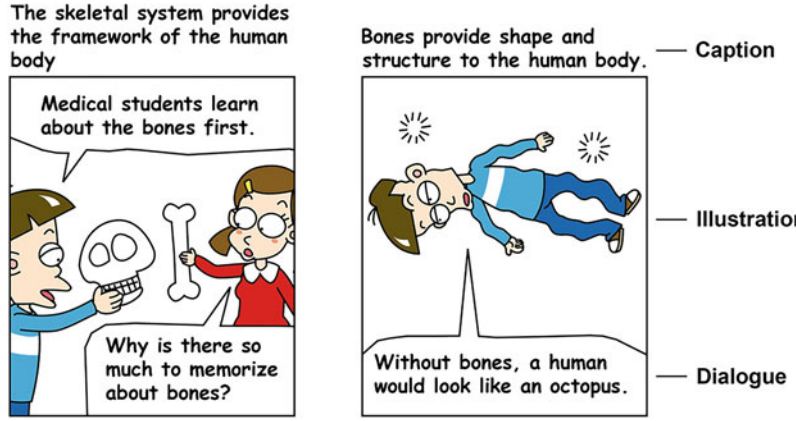

Fig. 1.4 Panels from anatomy education comic demonstrating combined use of dialogue, text, and illustration (Kim et al. 2017). Reproduced with permission

As one form of medical humanities, graphic medicine integrates both narrative medicine and visual arts and has been increasingly examined as a tool for advancing undergraduate medical education. Educators seeking new formats to reach students have turned to comics as a creative and engaging way to present both the humanities and scientific information. Despite the fact that many students have not been exposed to medical comics, one study found that after a brief introduction to graphic medicine, the majority of over 600 surveyed students perceived medical comics as "useful" or "very useful" (Adamidis et al. 2022). This enthusiasm for the format may possibly lead to better information retention and acceptance from learners. For example, 84% of medical students at Penn State College of Medicine who reviewed educational comics prior to completing their psychiatry clerkships reported high satisfaction in terms of information presentation and convenience (Joshi et al. 2019).

Integration of comics into medical education is not confined to the field of humanities, however. Efforts have been undertaken in various contexts to use comics as an aid for education regarding topics as diverse as statistical concepts and microbiology (da Silva and Vieira 2022; Tigges et al. 2021). There is also a growing interest in using comic formats as a way to humanize numerical data visualization, with applications of such "data comics" found both as standalone instruments and as explanatory insertions among graphic pathographies (Engebretsen and Kennedy 2020). As part of one such application of graphic medicine to scientific undergraduate medical education, anatomy professors at two medical schools in Korea have created and used more than 700 comics to engage students in course material and convey important points in a field that some students might otherwise believe "seems boring" (Park et al. 2011). Intervention using educational comics on basic human anatomy found medical students who were presented with graphic medicine material had improved course grades (Kim et al. 2017). In this series of comics titled "*Anna & Tommy*," students are provided content through a mix of infographic or diagram-based materials combined with segments of dialogue and interaction between characters, as demonstrated in Fig. 1.4.

In addition to helping medical students master scientific information, comics can also be used to help learners develop professional skills, understand different points of view, and enhance clinical reasoning. Thacker et al. used a transdisciplinary graphic medicine teaching session as a case study in helping undergraduate medical students explore the difficult topics of clinical complexity and uncertainty (Thacker et al. 2022). In a similar effort conducted by Vaccarella, students were introduced to core elements of the comic medium and guided through analysis of graphic pathographies, with the author suggesting that students "improved their understanding of narrative temporality by examining the sequential component of graphic

storytelling, and incorporated this new awareness into their diagnostic reasoning skills" (Vaccarella 2013). Qualitative analysis of survey and interview responses from third and fourth year medical students who viewed two comics about diabetes self-management found graphic stories to be a useful tool in simulating reflective practice and promoting empathy maintenance during training (Wang et al. 2018).

Examination of these illness narratives offers insights into the potential benefits for students. In his book *Diabetes: Year One*, author Tony Pickering uses a series of graphic poems to share his experiences of adjusting to a diagnosis of type 1 diabetes (Pickering 2017). Learning about diabetes self-management from a textbook provides useful technical information, but seeing the patient's experience of daily life, including the interruptions posed by medications, testing, and fluctuations in blood sugar helps contextualize illness as one part of a patient's broader story (Pickering 2019).

While teaching graphic medicine to medical students might seem difficult given the inherently subjective and individualized aspects of reading comics, several different strategies have been proposed to help facilitate students' exploration of artwork in humanities education. One such strategy is the "Visual Thinking Strategy" (VTS), which involves the following three questions: *(1) What's going on in this piece? (2) What do you see that makes you say that? (3) What more can we find?* (Myers and Goldenberg 2018; Yenawine 2013). These questions can be sequentially utilized and discussed with medical students to dig deeper into each graphic medicine piece they encounter.

Another example of potentially useful discussion prompts comes from a case study that explored a co-learning experience between the physician and patient (Anderson et al. 2016). The following discussion questions from Anderson and colleagues are intended for the physician and patient to answer, but they can also serve as prompts that may help students navigate reflection upon reading a graphic medicine piece:

1. *Whom did you identify with and why? Whom did you not identify with and why not?*
2. *What did each need to know about the other?*
3. *As the patient, what would you want the doctor to have done differently? As the doctor, what would you want the patient to have done differently?*
4. *How might this story change your next doctor–patient encounter?*

In addition to medical education interventions which involve reading and interpreting graphic medicine, some institutions have provided opportunities for medical students to create their own original comics as a form of self-reflection on a variety of themes, including their formation as clinicians, abuses in training, the role of medicine, patient connections, and handling emotional experiences. At Penn State College of Medicine, Dr. Michael Green, MD, MS has been teaching an elective course on graphic medicine to fourth year medical students since 2009 where, in the context of a broader introduction to graphic medicine, medical students produce their own comics (Green 2013). Upon assessing comics produced by medical students who took the course over the span of 6 years, Green found recurring themes including *"(1) how I found my niche, (2) the medical student as patient, (3) reflections on a transformative experience, (4) connecting with a patient, and (5) the triumphs and challenges of becoming a doctor"* (Green 2015).

The themes explored in these comics produced by medical students are important for self-reflection as medical school is a transformative experience involving both personal and professional growth as well as significant stress and anxiety. In one analysis of themes in comics produced by medical students, the most commonly coded theme was "overwhelmed," with other common content descriptors including "inadequate," "frustrated," and "helpless" (Maatman et al. 2020). Graphic medicine creates a safe and relaxed space for medical students to explore these experiences, thoughts, feelings, and reflections (Whiting 2020). The perceived informality and safety of comics is a strong stimulus toward open disclosure and externalizing distress;

in one analysis of 240 students invited to share a stressful experience in comic format, approximately 19% reported sharing a stressful experience via comic that they had never shared with anyone else before (Maatman et al. 2022b).

1.6 Graphic Medicine in Graduate Medical Education

While the potential for graphic medicine's use in graduate medical education has received less attention than that of undergraduate medical training, there is growing interest in using graphic medicine in this context, and several recent projects have attempted to incorporate comics into training after medical school. Like medical school, residency and fellowship training are periods of transformative professional and personal growth; however, time and energy are two resources that many residents find lacking due to the intensity of training. In the setting of these limitations, graphic medicine may offer advantages as an efficient and engaging medium for learning. Graphic medicine at this level of medical training is generally divided into two types of activities: (1) **receiving:** reading and discussing medically relevant comics, and (2) **delivering:** drawing comics to share experiences and self-reflect (Maatman et al. 2022a).

Including graphic medicine in graduate medical education can serve to teach residents skills and highlight important aspects of patient care and empathy, in similar ways to the previously described applications of comics in undergraduate medical education. Internal medicine residents from the Medical College of Wisconsin found that using a comic book to learn about patient safety was both acceptable as an educational exercise and increased their confidence in their ability to identify patient safety issues (Maatman et al. 2019). In a study conducted among neurology residents who participated in a 4-week graphic medicine seminar (which involved reading and discussing graphic memoirs featuring neurologic disease), residents cited better appreciation for symptoms as well as increased empathy, with 97% reporting that the course was a "good use of their time" (Ronan and Czerwiec 2020). Similarly, endocrinology residents at the University of Toronto who completed a 12-month curriculum reading and discussing four graphic novels noted that the curriculum helped them with sharing difficult experiences and building empathy (Sutherland et al. 2021). In one effort directed toward patients cared for by resident physicians in an outpatient clinic, comics from a patient-centered transition packet helped patients identify their new doctor and improved follow-up rates (Pincavage et al. 2015).

While few efforts have yet been undertaken to incorporate graphic medicine into surgical postgraduate training, the intersection of visual art and surgical science offers valuable opportunities for honing skills in diagnosis, observation, and communication (Cohen et al. 2022). Visualization and a strong knowledge of anatomy are especially important components for a successful surgeon, and surgical education has long relied on accurate medical illustrations in teaching anatomy and procedural techniques (Netter 1957). With a strong foundation for graphic learning already established as part of surgical textbooks and presentations, graphic medicine might seem to be a natural fit for conveying information in the field. In one exploratory attempt to present preparatory surgical information in comic form, residents and nurses were presented with a graphic narrative titled "The Thyroidectomy Story" as a supplement to previously delivered lecture and text materials surrounding thyroidectomy with the goal of introducing "technique, narrative, and medical illustration skills (interpersonal communication skills)" (Babaian and Chalian 2014).

1.7 Graphic Medicine Creation as a Platform for Processing Experiences in Health Care

Outside of the context of structured medical education, many students, trainees, and practicing clinicians have turned to creating graphic medicine both privately and publicly as a forum for

reflection, communication, and community-building (Kasthuri and Peter 2021). Sharing work publicly through online social media platforms such as Twitter and Instagram offers rapid feedback, responsive discussion, and expressions of support or empathy from colleagues or patients alike. In online graphic medicine posts, trainees and practicing professionals from across disciplines have shared comics reflecting on their experiences both in the clinical setting and in their lives outside of practice. While these efforts rarely appear to be created in the context of a structured therapeutic relationship, some creators appear to benefit from the catharsis and processing. Graphic medicine has potential as a powerful mechanism for self-reflection, including processing of negative or traumatic experiences that occur in the practice of medicine (Czerwiec et al. 2015).

Comics can also be utilized to record transformative or connective experiences with specific patients. Dr. Mike Natter, who is now a practicing endocrinologist, created monthly "Progress Notes"; graphic medicine pieces for Annals of Internal Medicine to document his experiences of the medical training process. In one such piece, titled "Tethered," Natter relays his experience as a resident of caring for a patient "trapped" in the hospital on an infusion, with limited options for discharge due to her uninsured status (Natter 2019). In a few simple panels, he intimately conveys their shared feelings of helplessness as doctor and patient.

Another highly active creator in the online graphic medicine space has been author and physician Dr. Shirlene Obuobi, who goes by "ShirlyWhirlMD" online. She has used her comics for years over the course of medical school, residency, and fellowship to explore a variety of topics including the traumas of training, attempts to maintain work–life balance, gender inequities, and systemic racial injustice in medicine. By using comics, she is able to address difficult and complex topics in a more accessible and less "hostile" format (Obuobi et al. 2021).

1.8 Comics and Sequential Art in Public Health Education

As the success of any public health education initiative relies on its ability to effectively engage and inform a broad audience, there has long been interest in using comics for this purpose. In light of the many unique properties of comics discussed above, graphic medicine has tremendous potential for engaging wide and diverse populations surrounding topics in science and medicine that otherwise might seem inaccessible (Farinella 2018). Public health initiatives have been using various forms of sequential art for decades to educate about topics as diverse as skin cancer, HIV/AIDS, and the dangers of smoking (King 2017). As early as 1950, the New York State Department of Mental Hygiene published its "Chic Young's Blondie in: Scapegoat, Love Conquers All, Let's Face It, On Your Own" to promote mental health services (New York State Department of Mental Hygiene 1950).

Other health entities utilize comics to promote awareness, prevention, and detection practices for certain medical conditions. For example, a 16-page comic book on skin cancer was distributed to 8000 households to educate the recipients about early signs of skin cancer (Putnam and Yanagisako 1982). The study coordinators found that readers described the comic as accessible and that the comic promoted change in increasing the use of sunscreen, protective clothing, and skin self-examinations (Putnam and Yanagisako 1982). In another study, adolescents who read an AIDS education comic scored higher on levels of knowledge regarding HIV transmission and prevention compared to the control group (Gillies et al. 1990).

A more recent application of graphic medicine for public health education is a comic created in Seattle to help the public understand necessary steps to take during a large-scale emergency that requires medical countermeasures (Li-Vollmer 2018). The creators believed that using a comic, with better integration of narrative, dialogue, and emotion, would allow them to more effectively educate the public about what to do in times of

emergencies that require a medical intervention such as mass testing or medication administration, such as a pandemic. The study materials used illustrations paired with clear instructions to inform people about what to expect and encourage them to have an action plan in place ahead of crisis; while impact was not measured, the study authors reported strong engagement with the content online as well as broad reach through social media (Li-Vollmer 2018).

Another recent example of graphic medicine's application to public health is the use of comics to educate the public about nonalcoholic fatty liver disease (NAFLD) (Alemany-Pagès et al. 2022a). Researchers in Portugal created the comic book, "A Healthy Liver Will Always Deliver," using graphic narrative and accurate biomedical illustrations to convey information about NAFLD prevention, regression, and health outcomes (Alemany-Pagès et al. 2020, 2022b). In one panel of the comic, Alemany-Pagès and colleagues used illustration and text to demonstrate the progression of a healthy, red liver to a cirrhotic, black and bumpy liver; they also gave each hepatocyte a memorable cartoon face and showed the progression of emotions from happy to surprise to uneasy and ultimately to the death of each cell interspersed with fibrotic tissue. Such blends of creativity and data have the potential to engage audiences who might otherwise ignore a text-only educational tool.

When paired with a strong base of culturally aware practices (such as audience involvement to inform accurate dialogue and illustrations), comics can also be a rich platform for telling stories in public health that incorporate perspectives not typically included in Western narratives. "Lissa: a story about medical promise, friendship, and revolution" is a long-form graphic medicine piece set during the Egyptian revolution that explores a broad variety of topics, including social determinants of health for the development of kidney and liver disease, genetic risks for breast and ovarian cancer, healthcare accessibility, and the interplay between public health and political revolution (Hamdy et al. 2017; Hamdy and Nye 2019). Using a combination of research and numerous interviews with affected populations, the team used comics as the medium for disseminating the story to "show" rather than "tell" the ways that political dynamics influence individual health within a broader global framework (Hamdy and Nye 2019). The team's well-informed attention to appearance, dress, and scenery in the narrative draws readers into another perspective in a way that text-only materials might not capture.

Numerous additional applications of comics as the medium for public health outreach help re-center the focus of medicine on patients' experiences and allow readers to glimpse into the inner monologues of those directly affected. When created with culturally appropriate and sensitive graphics, comics can be a valuable tool for helping the public gain a better understanding of the information being presented and how it applies to their own lives.

1.9 Graphic Medicine During the Era of COVID-19

The COVID-19 pandemic provides an excellent case study in highlighting the diverse applications of comics in health for creators, clinicians, health authorities, and the public. In early 2020, when much of the world shut down to contain the spread of the novel coronavirus, a variety of daily activities including work and communication had to rapidly shift to online virtual means. This mandatory isolation presented challenges for disseminating accurate science communication and public health updates as new research on curbing the pandemic evolved. Comics served as a natural way to fill those needs by presenting scientific information in the form of engaging narratives that were easy to create and share despite widespread social distancing (Kearns and Kearns 2020). The *invisible* nature of coronavirus as a viral pathogen made science visualization especially important for education of a public that maintained a broad spectrum of receptiveness to information and a broad range of health literacy levels. With much of the world already transitioning work and communication to online spaces at the height of the pandemic, comics

offered a natural vehicle for communicating through the internet. From a broad view, the COVID-19 pandemic offers a dramatic practical representation of nearly all the applications of graphic medicine described in prior portions of this chapter.

One of the most common applications of comics during the early stage of the pandemic was patients using graphic pathography to tell their stories of illness, caregiving, and loss with COVID-19. Several people who contracted COVID-19 created comics that illustrated their thoughts as they managed symptoms with the infection progression. Jason Chatfield, a New Yorker cartoonist, documented his experience with COVID-19 as a public warning in his graphic medicine piece "Covid-19 Diary" (Canva 2020). In this comic, Chatfield provides caricatures of his physical symptoms including fevers, aches, chills, and anosmia to tell his personal story. Other individuals created comics to cope with social isolation and find humor amid frustration or loneliness. For example, professional cartoonist and author Roz Chast created and posted comic panels through social media, highlighting hyperbolic extremes of pandemic behavior, such as panic buying Fig Newton boxes or placing the family dog into a hazardous materials suit. Such creation and sharing were not confined to professional artists, as members of the lay public also used artwork to share stories of frustration, humor, suffering, and illness, or to exhort others toward safety measures to slow viral spread. Regardless of skill level, patients of all ages and backgrounds used comics as a means of documenting their lived experiences during the pandemic, both positive and negative.

In addition to individual pathographies, comics were also utilized by institutions and larger medical entities as public health initiatives to educate the public about measures to slow viral spread. Comics provided a more approachable communication medium to motivate the general public, including children, toward responsible behavior during the global pandemic (Ghia et al. 2020). The National University of Singapore Yong Loo Lin School of Medicine published "The COVID-19 Chronicles," a series of 100 educational comics that explored the pandemic and educated readers in a humorous yet effective way (Kearns et al. 2021a; Tan and Yong Loo Lin School of Medicine 2022). Alongside comics that aimed to address responsible behavior in public settings, comics about the vaccine and its benefits were created to aid in the COVID-19 vaccination campaign. "Having a Vaccine for Coronavirus" by Sheila Hollins and illustrated by Lucy Bergonzi is a short graphic medicine piece that utilized basic health icons instead of words in its panels to recount the vaccination experience, answer questions, and ease fears about pursuing a vaccine (Hollins 2021).

In addition to broader institutional efforts, individuals who wanted to share additional accurate information about curbing the virus also took advantage of the spread of comics via social media to educate others. For example, Dr. Ciléin Kearns, a medical illustrator and doctor who uses the moniker "Artibiotics" online, created several infographics that describe best practices including social isolation, proper hygiene, and information about the spread of COVID-19. Using bold colors, Kearns employed a combination of graphs and text to show how transmission occurred between the affected and unaffected, with red clouds representing transmission of viral particles through short-range aerosol particles (Kearns and Kearns 2020). Other practitioners used their knowledge and background in medicine to design comics to combat misinformation about COVID-19. Dr. Tommy Brown, a doctor in the United Kingdom created comics to debunk several COVID-19 conspiracy theories including the myth that face masks causing carbon dioxide poisoning, concerns that the vaccine might change the recipient's DNA, and the misconceptions that the vaccine had been rushed through the approval process or was only for the elderly or at-risk populations (Brown 2021).

At the height of the pandemic, practitioners were often left to wrestle in isolation with both the physical and emotional toil of widespread death, suffering, and uncertainty. They were cut off from a public that at times had little understanding of what was happening within healthcare settings. Many clinicians turned to comics to

share their experiences, process their traumas, and educate the public about what they were seeing in clinics, nursing homes, emergency departments, and the hospital wards. These comics created by practitioners offered the public a window into spaces that were often left unseen by non-clinicians during the strict isolation precautions instituted at the outset of the pandemic (Callender et al. 2020).

In one example, an intensive care unit nurse Agnes Boisvert from St. Luke's hospital in Boise, Idaho and illustrator Isabel Seliger collaborated to produce a comic for National Public Radio (U.S.) entitled, "How One COVID-19 Nurse Navigates Anti-Mask Sentiment," to share Boisvert's personal experiences grappling difficult emotions including anxiety, hope, disappointment, and frustration during the pandemic (Kellman et al. 2021). Boisvert describes her challenges in facing the anti-mask sentiment in her community while trying to educate them about all the loss and death she witnesses in the hospital (Kellman et al. 2021).

1.10 Challenges and Future Directions

Despite the promise and potential of creating and disseminating graphic medicine to improve healthcare, significant challenges and opportunities remain. Comics have long wrestled for recognition and legitimacy against stereotypes of the medium as "low-brow," juvenile, or primarily recreational rather than educational. This ambivalence or bias against comics may be particularly pronounced in some arenas of academic medical education, where even the terminology of "comics" may be avoided in favor of terms that appear to lend greater cultural authority, such as "graphic novel" or "graphic essay" (Humphrey 2014). While interest in comics is growing among medical schools, clinicians, and even scholarly scientific journals, longstanding misunderstanding of the medium may still create barriers to use. Some individual readers who do not consider themselves comic consumers may also be resistant to the idea of accepting comics for educational or coping purposes due to preconceived ideas about the medium.

While the accessibility and openness of comics as a medium for anyone invites many creators into the process, the highly subjective nature of graphic medicine also provides room for unforeseen misinterpretation and possible challenges in making comparisons among different pieces of work. Experiences of illness are also by their nature individualized and not always generalizable to the general public. Dramatic imagery could promote connection among patients sharing an illness or could provoke anxieties or anticipatory distress in patients delving deeply into the experiences of someone whose illness has progressed beyond their own; thus far, there is little research into the effects of reading graphic pathography among patients affected with the illness represented.

Graphic medicine's use of caricature, hyperbole, abstraction, metaphor, and an author's visual recall to convey emotional or traumatic experiences may also leave the field subject to criticisms that readers are being offered a view of illness and healthcare that is more "fiction" or embellishment rather than "fact." However, Pedri argues that this unique space of graphic memoir, not wholly constrained to either fact or fiction, may be part of its power—abolishing the boundary between the two and allowing the creator to better represent and acknowledge their inherently subjective experience of events (Stein and Thon 2013).

In addition to theoretical constraints mentioned above, there are practical barriers to the implementation of comics in education. Making high-quality educational comics is an extremely labor-intensive process that involves careful planning, scriptwriting, drawing, and sometimes coloring. Adapting materials to language and developmental level also requires deliberate attention to the nature of both text and illustration. For example, if a comic is intended for children or pediatric patients, using vocabulary appropriate to developmental level and less detailed imagery may help readers better understand the story. However, these challenges are not insurmountable. Medikidz is a global initiative that has

successfully created a broad library of comic materials directed at illness and healthcare education for children and youth, using the combined expertise of comic creators and physicians (Thakkar 2011). Their model has been extremely successful, distributing millions of copies of books explaining topics as diverse as cancer, clinical trials, and head lice.

In addition to the practical challenges of creating comics, measuring graphic medicine's effects and impact can also be difficult. Most studies only look at short-term effects of graphic medicine exposure or have used primarily qualitative data to demonstrate potential uses (Gillies et al. 1990; Kim et al. 2017). Future studies need to also examine the long-term effects of graphic medicine on learning and memory retention, employing controls or comparators, and ideally using larger samples with randomization. Another difficulty is heterogeneity of intervention, which is inherent to graphic medicine studies. Comics can take an infinite number of styles, forms, and quality, making it difficult to generalize positive findings regarding the successful application of one comic to similar applications of different comics, even for the same general purpose. While studies of text versus comics have been undertaken, future study should also compare comic formats of education delivery to other modern media methods including video and interactive digital tools. Such data would bolster the case for comics and help overcome bias against the comic medium as a serious form of information delivery.

Finally, as the role of graphic medicine in healthcare and education grows, it is important to ensure that comics are inclusive and broadly applicable. Creating comics that connect with their intended audience through sensitive and appropriate character representation is critical, but requires deliberate effort (Hague and Ayaka 2018). Having visually relatable characters can help readers better place themselves into the narrative, but the nuances of accurate use of language, dress, and culture can be difficult to capture without preparation. Ill-informed or inaccurate attempts to connect with the idiosyncrasies of culture could actually alienate rather than engage an audience. "Lissa: a story about medical promise, friendship, and revolution," mentioned previously, provides an example of how intensive contextual effort can help a production team develop a culturally appropriate reflection of characters in a long-form comic book; the production team for this graphic narrative relied on hundreds of interviews and ethnographic research in Egypt and the USA in the process of producing their comic (Hamdy et al. 2017).

A promising response to the challenge of developing culturally sensitive and accurate graphic medicine materials is the involvement of potential intended audience members in conceptualization, creation, and editing of materials. When comic materials are created with the aid of the intended target audience, the individuals' expertise in their lived experience can be merged with the technical expertise of comic creators and public health educators. In one such effort, McNicol and Leamy describe a case example of collaboration between people living with dementia and the study team, working together to create comics about dementia (McNicol and Leamy 2020).

In another example of such co-creation, public health researchers "crowdsourced" educational models for HIV pre-exposure prophylaxis (PrEP) in China through an open call for content material and also invited participants from the community to be part of the judging process (Sha et al. 2022). Comic formats were one form of materials submitted and were chosen as part of the final selected content for integration into the intervention, which will be rolled out among the study participants with follow-up over 12 months to assess effectiveness in promoting PrEP adherence following initiation. Future graphic medicine work like this, involving partnership with the community during both conceptualization and creation, has the potential to better ensure that materials are relevant and useful to their target audience.

1.11 Conclusions

The expanding forum of graphic medicine offers a wealth of opportunities for communication, connection, and coping in science and medicine. The scope and acceptance of graphic medicine continue to grow rapidly, mandating ongoing development in comics literacy and scholarship to guide the development of the field. While the scope of this review is by no means comprehensive, we have attempted to provide a broad overview of advantages of the comic medium as a vehicle for delivering content in a way that humanizes health information through art and narrative. In addition, we have highlighted diverse current and future uses for comics in education, patient care, and public health, along with challenges that lay ahead for the study of graphic medicine. Among an ever-expanding field of routes for education and connection, graphic medicine holds an evolving and promising place for the future.

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