Visual aids in patient-focused drug development and routine clinical practice

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Abstract

Effective medical communication is critical for patient consent, adherence to treatment, and improved health outcomes. Visual aids, such as infographics, diagrams, and charts, have proven invaluable for enhancing comprehension, particularly of complex medical concepts like risks and numerical data. Historically, medical visualisations have played a vital role, from Renaissance anatomical atlases to modern-day graphical abstracts and patient-centred infographics. Innovations in visual communication underscore their transformative power in healthcare. Despite their long-standing utility, visual aids remain underused in patient information, which often suffers from overly complex language and poor design.

The integration of visuals into clinical trial reporting, informed consent forms, and treatment plans has gained momentum, supported by guidelines advocating for patient-focused communication. Recent studies confirm that well-designed visuals improve comprehension, engagement, and equity in healthcare communication. As user-friendly tools become more accessible, visual aids will become integral in advancing patient-centred, inclusive healthcare practices.

Introduction

Understandable medical communication is important for consent, adherence to therapy, and positive health outcomes, and is foundational for high-quality care. Pictures and visual aids have demonstrable benefits for comprehension, particularly for risk, uncertainty, and numerical information.[1] The importance of visualisations for medical writing has been highlighted in the March 2020 issue of *Medical Writing*, which showcased example explanatory visualisations, designs for study protocols, and graphical abstracts.[2-4] A notable article was even entitled with the well-known adage "A picture is worth a thousand words" and emphasised why humans are drawn to pictures and memorise information better when supplemented with visual components.[5] It is therefore not surprising that today data visualisations and visual aids are becoming more frequent in medical communication.

Pictures and visual aids in medicine – a look back

Pictures are not a new addition to the field of medicine: they have always been integral in medical practice and research and can be traced back to antiquity. Medical atlases were essential for physicians, offering illustrations of human anatomy and botanical diagrams of medicinal plants, but they were also admired by the elite.[6] Illustrations of the typical appearance of a plant or animal would serve as a reference and were passed along among scholars and regularly transcribed.[6] Atlases provided an accessible way to summarise and convey complex information in an era when literacy was limited, linguistic barriers were high. They were a portable means of communication.[7]

During the Renaissance, more systematic approaches to medical visualisation were developed, fuelled by technological advancements such as the printing press. Then in the 19th century extraordinary progress was made in data visualisation with the development of diagrams.[8] Notably, the advent of diagrams was largely driven by the need to communicate medicine and healthcare issues to politicians, patients (also those with no or low literacy), and newly trained healthcare workers. Several data visualisation pioneers were working in the medical sector at this time, namely Florence Nightingale, John Snow, and Étienne-Jules Marey. Among these three: Nightingale developed the "coxcomb" diagram to visually demonstrate the positive effect of healthcare reforms for saving soldiers' lives; Snow established cartographic maps as a tool to trace cholera cases and visually reveal epidemiological hot spots; and Marey invented movie animations to capture the intricacies of human motion.[9,10]

Notably, the advent of diagrams was largely driven by the need to communicate medicine and healthcare issues to politicians, patients, and newly trained healthcare workers.

The recent Coronavirus 2019 (COVID-19) pandemic once more underscored the critical importance of the healthcare sector, and its role in tracking, exploring, and explaining diseases to empower individuals and policymakers to make informed decisions. In addition, today's digital tools and user-friendly software power the adoption of data visualisations widely in the healthcare sector. A non-exhaustive summary of open-source user-friendly software, icon libraries, and web-based illustration tools is provided in Table 1.

Health literacy challenges and the need for visual aids

Patients' involvement in clinical trial design, such as identifying key endpoints and measures, has received increasing attention in recent years. In the EU, the EMA has introduced initiatives to enhance patient involvement in regulatory decision-making, such as the Patient Engagement in the Benefit-Risk Assessment of Medicines

Table 1. Tools and resources for prototyping visual aids

Name	What is it used for?	Website
General icons		
SVGrepo	Large scalable vector graphic icon library, search function for icon style and appearances (colour, line style).	https://www.svgrepo.com
Fontawesome	Unicode-based icon library with many free icons, individual/batch download as scalable vector graphic (SVG).	https://fontawesome.com
PowerPoint	Inbuild image and icon libraries and many pre-drawn shapes that are free to use.	
Biology icons		
Bioicons	Expanding repository of biology and laboratory icons from petri dishes to model organisms available under free licenses (CC0).	https://bioicons.com
NIH BioArt	A collection of free, high-quality, vectors, icons – created by professional illustrators.	https://bioart.niaid.nih.gov
Phylopic	Shapes of numerous animals, plants and further model organisms, e.g., for phylogenetic trees.	https://www.phylopic.org
Reactome	Provides scientific pictograms and chemical drawings for free re-use and encourages the upload of user-designed pictograms for sharing with the scientific community.	https://reactome.org/icon-lib
SciDraw	Free repository of high-quality icons.	https://scidraw.io
Medical icons		
HealthIcons	A global volunteer effort to create common icons for many specialised medical scenarios available under creative commons license (CC0).	https://healthicons.org
SmartServier	A free collection of medical drawings from Servier Medical Art that can be downloaded as a full slide-deck and used with attribution	https://smart.servier.com
Design tools		
Figma	Online prototyping, free form, charts, and icons can be integrated.	
Inkscape	Open-source, offline, professional vector graphic program, compatible with programming approaches, expandable functionality with packages.	

project. This initiative aims to ensure that clinical trials and drug development processes reflect patient priorities and improve accessibility.[11] The US FDA released a set of guidelines to facilitate patient-focused drug development to help clinical trial sponsors identify what matters to patients, and to ultimately design more clinically meaningful trials.[12]

However, while involving patients in drug development is gaining more traction, informed consent documents (e.g., for procedures, surgery, or medical treatments with material risks such as radiation therapy) are often focused on information necessary to protect against litigation.[13] A comprehensive analysis of consent forms from across US hospitals for surgical or invasive procedures revealed that these are written for a high reading level with a mean reading score of 12.6 (high-school graduate level) and additionally are often printed in non-legible print.[14] Similarly, in Europe, studies have shown that patient information leaflets and consent forms often exceed the recommended readability level. The European Commission has

guidelines encouraging the use of clear and simple language in medical documents, but implementation varies across member states.[15]

Likewise, oral communication is often too complex to be understood fully, and medical teams regularly overestimate the literacy of their patients.[16-19] Thus, many patients may not be able to effectively use health information and are at increased risk for adverse outcomes. Indeed, health literacy is one of the strongest predictors of an individual's health, and using visuals can help enhance comprehension and literacy.[20]

Visual aids in healthcare and clinical development

Despite their long history and benefits for communication, pictures and visual aids are still underused in most patient information. This is even more surprising considering the increasingly well-documented literacy and numeracy gaps between medical staff and patients, particularly in those experiencing cognitive decline due to age or stress brought on by health issues and medical interventions. These gaps challenge effective communication in healthcare settings. Visuals can help bridge this gap by improving comprehension and ensuring that information is accessible to a broader audience.

Visual aids in patient-focused drug development

The drug development process can be broken down into three broad phases: pre-clinical development, clinical development, and clinical practice. Visual aids are mostly used during the second and third phases for the purpose of communicating with the public (here defined as patients, carers, and other lay persons) (Figure 1). During drug discovery in the pre-clinical phase, most documents are prepared for expert audiences or regulatory authorities; therefore, the visuals' primary purpose is to communicate the research data in graphs and charts.

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Once a drug enters clinical development, presenting information to the public, investigators, and clinical trial personnel in a digestible way becomes more important. Clinical studies are lengthy, quality controlled, and regulated procedures with documents that are tens to hundreds of pages long. As patients are more and more actively involved (for instance, through patient boards), it is increasingly mandated that trial information is accessible to them, i.e., with lay-person summaries and visual aids. In the EU, since 2014 the EMA has required lay summaries of clinical trial results under the Clinical Trials

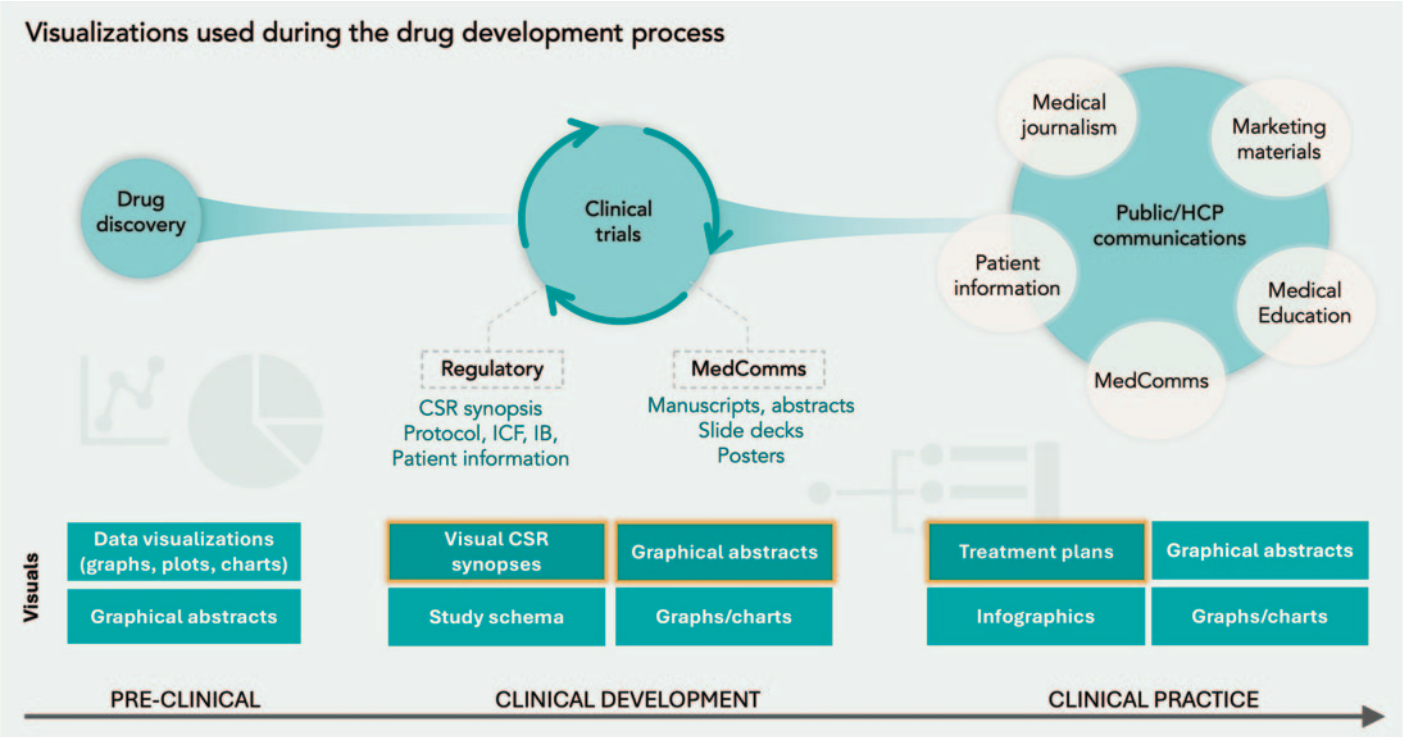

Figure 1. Overview of selected key documents and visualisations during the drug development process

Broadly, drug development can be broken down into three phases of pre-clinical research and development, clinical development, and marketing and clinical practice. During the pre-clinical drug discovery phase, visuals are mainly used to present research results to other experts using data visualisations, and graphical abstracts can accompany research manuscripts. During the clinical development phase, patient focused communication becomes more important, where explanatory visuals can used in regulatory documents (study schema in protocols or visual CSR synopsis). In addition, medical communications are used to communicate trial results in manuscripts, slide decks, posters, etc., and these are often accompanied by visualisations. In routine clinical practice, accessible public and HCP communications become even more crucial. Here visuals can be used to enhance content for medical education, patient information, marketing and other materials.

Abbreviations: CSR, clinical study report; HCP, healthcare personnel; IB, Investigator's Brochure; ICF, informed consent form; MedComms, medical communications.

Regulation (EU No. 536/2014), ensuring that patients can access comprehensible trial data.[21]

One of the most crucial documents at the beginning of a clinical trial is the clinical study protocol, which is meant to be an easy-to-use reference for investigators throughout the study. Study schemas are diagrams used in the protocol synopsis to present the most important milestones and interventions of the trial, and a well-designed schema can be of great help to investigators and used for quick reference. However, a poorly designed or inconsistent diagram can slow processes and hinder understanding; therefore, study schemas always need to be checked for consistency with the rest of the protocol. The Investigator's Brochure is another important document at this stage, which summarises all available information about a drug that the investigator can reference. Here, visualisations are primarily used for presenting data, e.g., as graphs and charts.

Two key public-facing regulatory documents in clinical trials are the informed consent form (ICF) and the lay summary of the clinical trial results (the second being a requirement by the EMA for submissions within the EU). An ICF explains to patients what is going to happen to them during the trial and importantly, what risks and potential benefits they may see – it is their primary source of information for the procedures they agreed to participate in. While the International Council for Harmonisation of Technical Requirements for Pharmaceuticals for Human Use (ICH) guidelines (E6[R3]) outline the requirements for the *content* of an ICF, the *presentation* should enhance understanding using design principles and simple graphics.[22] In Europe, the Plain Language Summaries initiative is gaining traction, aiming to improve patient understanding of complex medical information through simplified text and visuals.[21,23]

On the other end, the clinical trial lay summary explains the key results and takeaways of a trial. For this document, the official guidelines already suggest supplementing the text with infographics.[21] Interestingly, the International Kidney Cancer Coalition has been one of the first alliances that offer downloadable, patient-friendly infographics for clinical trial results, but the documents' design has its drawbacks.[24] The downloadable documents include overcrowded graphs and densely packed data that can make interpretation challenging. The combination of small fonts, insufficient contrast, and complex visual elements may reduce readability and accessibility for some readers. Additionally, the document's findability is hindered by a lack of descriptive metadata, such as searchable keywords, alternative text for visuals, or clear tagging within the file. This

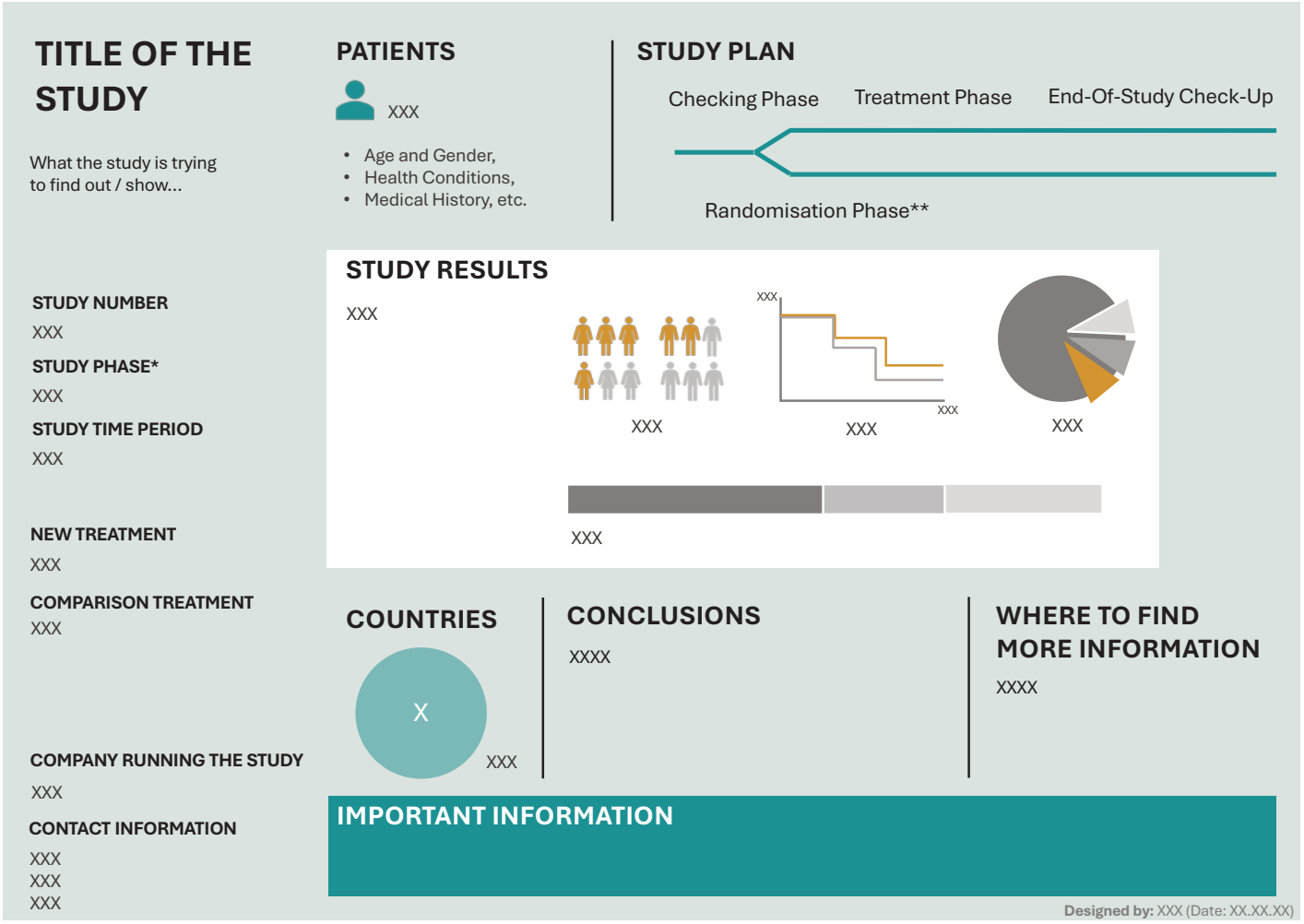

Figure 2. Template for a visual clinical study report (CSR) synopsis in lay language

*The study phase is an optional element that may require further plain language explanation in a callout box.

**The term "randomisation" requires explanation in plain language in a callout box. Please feel free to download the original .pptx template (size: 71 KB) here: https://drive.google.com/drive/folders/1iS5ZV1-GBCoZO5kbvGFdM5ZuEph2bMOw?usp=sharing

omission can make it difficult for lay audiences to locate relevant information or navigate the content efficiently.

Once a trial is finished and the results can be publicly disclosed, various tools of medical communications are used to explain the results, e.g., graphical abstracts to accompany manuscripts, educational slide decks, and patient information documents. Typically, visual aids are heavily used to support these communications.

Simplifying layouts and enhancing the clarity ot charts can improve the visual effectiveness of the above documents. For that reason, we created downloadable, exemplar PowerPoint templates for a visual CSR synopsis (Figure 2) and a graphical abstract (Figure 3) in lay language.

Key elements of our templates:

1. **Structured layout**: A4 size (CSR synopsis) or A5 size (graphical abstract), horizontal layout with clearly divided sections, such as "Study Plan", "Study Results", "Sites", "Countries", etc.
2. **Icons and graphics**: Use of simplified icons (e.g., for patients), charts, and graphs (e.g., bar chart, pie chart, survival curves) to visualise datc
3. **Colour coding**: Minimal use of colours to differentiate sections or elements, focus on colour accessibility (e.g., visible to audiences with colour vision deficiency).
   In our example the following colours were used:
   - Teal: RGB (63, 143, 146), Hex #3f8f92
   - Orange-brown: RGB (200, 148, 71), Hex #c89447
   - Black: RGB (0, 0, 0), Hex #000000
   - White: RGB (255, 255, 255), Hex #ffffff
   - Medium grey: RGB (127, 127, 127), Hex #7f7f7f
   - Light grey: RGB (217, 217, 217), Hex #d9d9d9
4. **Typography**: Bold headings and readable font sizes to emphasize key points. In our example the typography uses a **sans serif** font (e.g., Aptos, Arial, Helvetica), which is commonly chosen for clean, modern layouts in presentations and infographics.
5. **Infographic style**: Presents complex information in a concise, visual format.

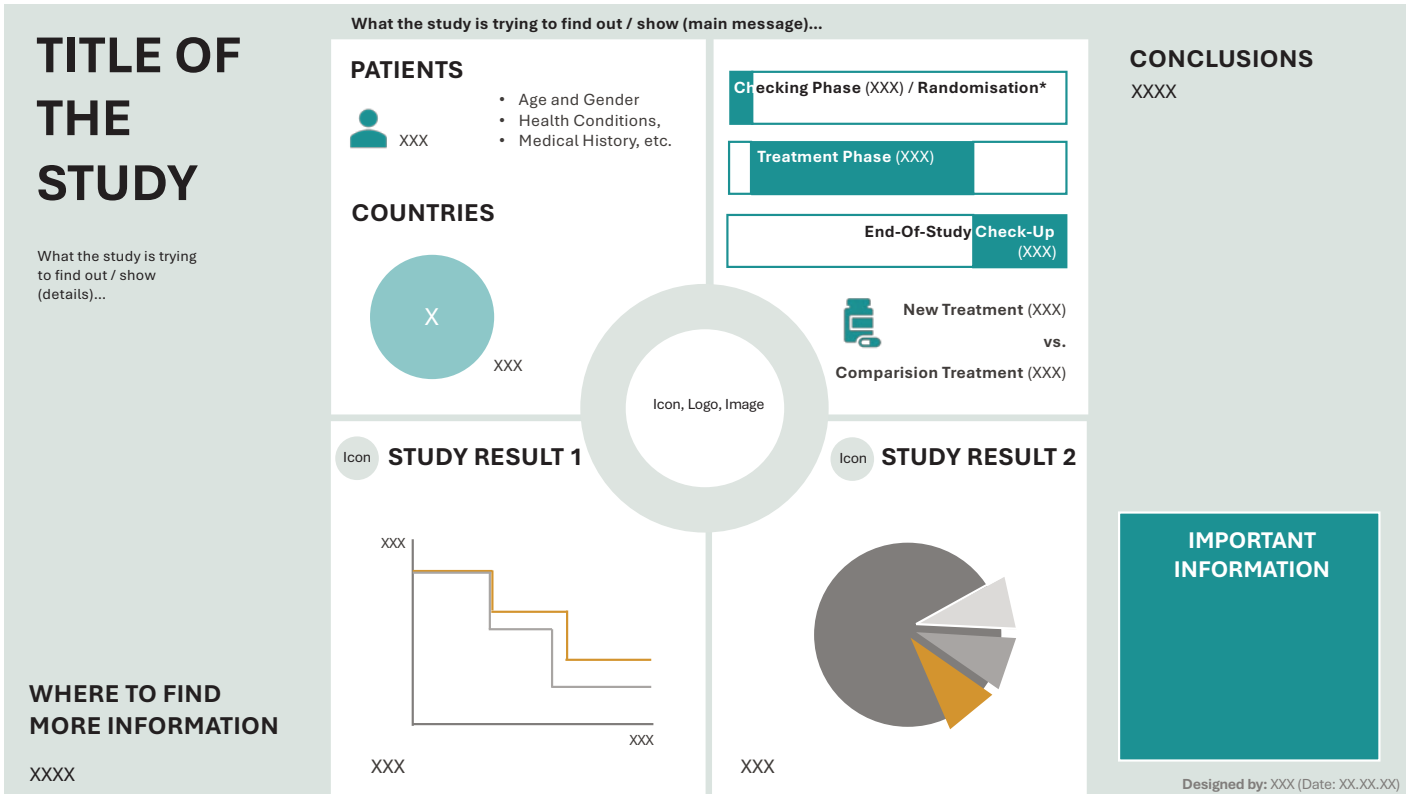

Figure 3. Template for a graphical abstract in lay language

*The term "randomisation" requires an explanation in plain language in a callout box. Please feel free to download the original .pptx template (size 104 KB) here: https://drive.google.com/drive/folders/1iS5ZV1-GBCoZO5kbvGFdM5ZuEph2bMOw?usp=sharing

We envisiage that a visual CSR synopsis in lay language may become an integral part of the CSR, whereas a graphical abstract in lay language could be an encore element in publications and social media communications.[25] However, visual aids in patient-focused drug development are often not findable by lay audiences due to several key challenges. They typically lack standardised metadata, such as keywords or descriptive tags, which hinders indexing by search engines and databases. Stored as non-searchable image files (e.g., PNG, JPEG, or PDFs), these visuals are rarely enhanced with alt-text or optical character recognition, making them inaccessible to search algorithms. Additionally, visual aids are often isolated from the full text of a clinical document or a publication and are not linked to related content, limiting their discoverability.[26] Poor integration with search systems and a lack of standardised terminology in captions or descriptions further reduce their visibility. To improve findability, medical communicators could enrich metadata, integrate image recognition technologies, adopt standardised formats, and ensure better indexing within scientific databases.

Visual aids in routine clinical practice

Once a product has received marketing authorisation and can be used in clinical practice, visualisations could take a more central stage. A wide range of visuals could be integrated in clinical care for different purposes, from eye-catching illustrations and simpler graphics for educational/informational content (e.g., for patient information leaflets, healthcare personnel training/advice materials) to more detailed infographics and visual abstracts (e.g., for study results).

To improve findability, medical communicators could enrich metadata, integrate image recognition technologies, adopt standardised formats, and ensure better indexing within scientific databases.

Explanatory visualisations have already become essential diagrams in clinical trials, prominently featured in graphical abstracts and participant education materials, and we recently contributed a comprehensive guide to their design.[27] Building on this, Jambor et al. recently conducted a comprehensive study and clinical evaluation of pictogram-based timeline visualisations for routine clinical practice, specifically in treating patients with haematological neoplasms.[28] These visual cancer treatment timelines were developed collaboratively with patient representatives and physicians and designed to summarise complex treatment timelines (Figure 4).

The study revealed that these visual aids significantly enhanced comprehension among participants and instilled a greater sense of security regarding their treatment. By comparing different formats for encoding key

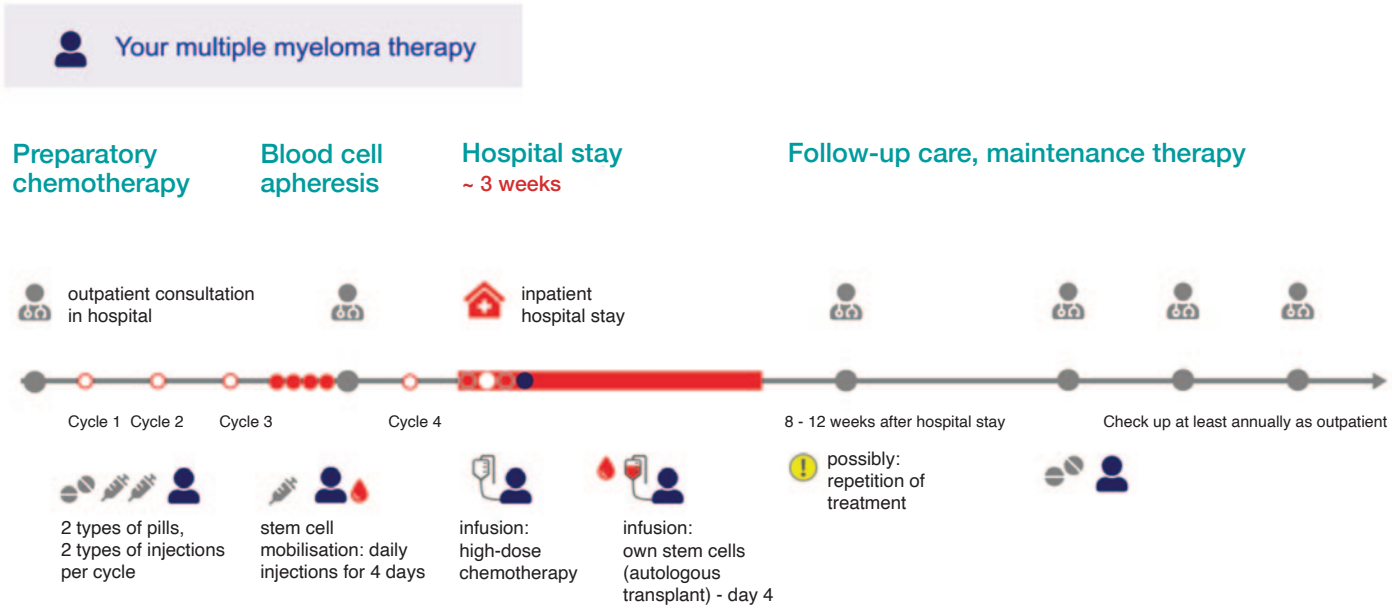

Figure 4. Example of a cancer treatment timeline visualisations (28)

information, the study demonstrated that abstract pictograms performed as well as, and in some cases better than, more realistic comics or photographs. These simplified visuals were particularly effective across all age groups, including older adults who are more frequently affected by haematological neoplasms.

In the EU, various healthcare initiatives have embraced visual tools to improve patient communication. For instance, the European Patients' Forum advocates for better use of pictograms and simplified visuals in patient information leaflets across EU languages, ensuring consistency and accessibility.[29]

Clinical evaluations further validated the utility of these visual cancer treatment timelines. Participants demonstrated improved information retention, and both patients and physicians perceived the aids as beneficial.[28] Importantly, these visuals made complex medical information more accessible to a diverse patient population, offering a promising strategy for enhancing equity in healthcare communication and outcomes.

Conclusions

Visual aids present a transformative opportunity to improve healthcare communication, aligning with the Institute of Medicine's quality criteria for patient-centeredness and equitable care.[30,31] The increasing availability of user-friendly software, icon libraries, and web-based illustration tools makes it easier than ever to design accessible and effective visual aids, even for non-experts.

By empowering patients to make informed decisions, these tools complement traditional methods of medical communication. Their adoption in informed consent processes, treatment plans, and clinical trial reporting is likely to become more widespread – and perhaps even mandatory – in the future. Incorporating visuals into healthcare dialogues fosters a more inclusive, engaging, and impactful approach to patient education, ultimately contributing to improved patient outcomes and equity in care.

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Disclosures and conflicts of interest

The authors declare no conflicts of interest.

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