NÚM. XX 2026
ISSN: 1989-4376

redit
Revista Electrónica de Didáctica
de la Traducción y la Interpretación

Medical animations in patient education: Insights from PubMed and implications for translation training and translation didactics

RECIBIDO 02/03/2026 | ACEPTADO 16/03/2026

IULIA MIHALACHE
https://orcid.org/0009-0002-6236-243X
Université du Québec en Outaouais (Canada)

ABSTRACT

This paper examines the terminology employed across PubMed publications to refer to medical animations in patient education, also looking at how content is assessed, and the ways in which narrative clarity, aesthetic engagement, and scientific rigor are balanced. The findings reveal both terminological ambiguity when labelling "medical animation" for lay audiences, and heterogeneous content evaluation frameworks. The paper also highlights the absence of medical animations as an area of investigation in translation research despite their growing role in multilingual health communication. And yet, their nature invites inquiry into multimodal translation strategies. Furthermore, medical animations can serve as a pedagogical tool for cultivating competencies that include multimodal literacy, visual literacy, collaborative knowledge negotiation, boundary-crossing inquiry, interdisciplinary conversation of narrative modes, scientific analysis, and creative synthesis of medical science, technology, visual communication, and language practices.

KEY WORDS: Medical Animations; Patient Education; Content Evaluation; Multimodality; Translation Training; Translation Didactics

1. MEDICAL ANIMATION AT THE CROSSROADS OF SCIENCE, ART, NARRATIVE, AND TECHNOLOGY

1.1. The field of medical animation

Medical animation—also referred to as "animation in the field of medical science"—is an interdisciplinary field that brings together medicine, art, communication, and technology. Combining scientific understanding, artistic creativity, communication, and technological innovation, it also functions as a mediating practice, turning complex biomedical data into accessible visual narratives that support education, research, and public engagement.

Medical animation as a field can be described as a specialized branch of computer animation (Verma et al. 2024: 294), comparable to architectural animation, forensic animation, educational animation, or mechanical animation, each of which visualizes complex systems for explanatory purposes. In this sense, it functions as both a communicative and educational practice, translating and adapting medical knowledge into visual form.

The terminology used to describe this domain is not entirely fixed. The expressions "medical animation" and "biomedical animation" are often used interchangeably—perhaps out of convenience—but they sometimes refer to slightly different realities. Medical animation generally refers to visualizations of human anatomy, clinical processes, or medical procedures, whereas biomedical animation, based on three-dimensional scientific visualization, tends to encompass a wider biological scope, including molecular and cellular mechanisms or other non-clinical life-science topics. The Medical 3D Animation Company (2025: online), for instance, describes biomedical animation as the use of "3D animations to educate students or patients about disease processes, genetics, immunotoxins, therapeutics, treatments, and biological markers". These animations re-create sub-cellular structures and dynamic interactions to make invisible biological processes comprehensible through motion and narrative.

According to the Association of Medical Illustrators (AMI) (2025: online), medical illustrators are professional artists trained in both the life sciences and visual communication who collaborate closely with scientists and physicians to create visual materials for scientific and educational purposes, including "instructional videos". From this perspective, medical animators can be seen as a subgroup of medical illustrators. Increasingly, medical illustrators also contribute to research settings, using their skills in modeling and data visualization to support scientific analysis. The specific skills required for medical illustrators are: a strong foundation in biological and medical science; the ability to work in both art and science to design images that accurately communicate anatomical content; strong visualisation skills to transform complex concepts and information into 2D and 3D images which are customized according to the audience; art and media production skills (including computer graphic skills) to meet the needs of the biocommunication industry; problem solving skills, as well as writing and research skills ("reading scientific papers, meeting with scientific experts, perhaps observing surgery or a laboratory procedure", *idem*). To relate this discussion to the field of translation studies (particularly concerning the area of visual skills), where reflection on the text as a multimodal product has developed through research on audiovisual translation, localization (website, software, video games), comics and graphic translation, as well as advertising and transcreation, but where "translation [still] needs to be redefined and reconfigured in contexts where multiple modes of communication, such as writing, images, gesture, and music, occur simultaneously" (Pérez-González, 2019: online), it is important to note that outside of these translation subfields, translators either do not engage with images when they are present in a text or they neglect the aspects of translation consistency and image generation consistency (Fu et al., 2026). In most translation workflows, computer-assisted translation (CAT) tools extract and convert documents in ways that preserve only the textual content, leaving visual elements aside to be handled by other experts with the help of software that does not belong to the traditional toolkit of translators. Therefore, what St-Jean observed in her 1996 master's thesis still holds true in certain contexts today: "[…] whenever visual components are encountered in text, translators are instructed not to attempt to analyze them, but simply to transpose these marks in the target language through a process of 'report'" (St-Jean, 2016: 15). However, visual literacy[1] is increasingly important nowadays because contemporary culture is dominated by visual media, and therefore, visual communication skills should be part of the translator training.

Going back to the terminology used to describe "medical animations", the use of 3D representations in biomedical animation "for the purposes of scientific education and illustration of biological processes" is also explained by The Peter MacCallum Cancer Centre. These animations, grounded in empirical scientific data, are used not only in research settings, but also in patient education, allowing patients and interested laypersons to understand complex molecular and cellular processes, for example in the context of cancer. Scientifically accurate, biomedical animations demonstrate how artistic expression and scientific precision coexist within the field.

In the academic context, biomedical animation is situated within the broader fields of biomedical communication and biomedical visualization. According to Miller and Kimmel (2001: 8), biomedical communication serves two key purposes: it helps individuals make informed health decisions and encourages public awareness and engagement in health-related policy debates. The University of Toronto's Master of Science in Biomedical Communications (BMC) program exemplifies this interdisciplinary approach, combining art, science, medicine, and communication to produce visual materials that support health education, medical training, and scientific discovery. Similarly, the Department of

1 According to Kedra (2018), visual literacy comprises three skill sets: (1) visual reading skills, including interpretation, analysis, perception, evaluation, and visual–verbal–visual translation; (2) visual writing skills, covering visual communication, creation, and image production and use; and (3) broader skills such as visual thinking, visual learning, and applied image use.

Art as Applied to Medicine at Johns Hopkins University includes biomedical animation as an integral part of visual communication for science and healthcare, underscoring its dual function as both a pedagogical tool and a method of research.

Finally, Statistics Canada (2024: online) recognizes the profession of "medical illustrator" as an occupational category that may specialize in biomedical animation or biomedical communications, defined as applying "art and computer-assisted imaging, graphics, and animation to create visual materials to facilitate the recording and dissemination of biomedical knowledge for educational, research, and clinical purposes".

According to Bolaki (2016: 209), "medical animation evolved from the field of realistic medical illustrations before it turned to computer-generated animation in the early 1970s". In other words, medical animation is not an abrupt technical novelty but a development of an existing visual culture of medicine which has a centuries-long history of striving for visual realism to teach anatomy and pathology (Netter and Friedlaender 2014). From Leonardo da Vinci's anatomical drawings of muscles with cords and strings, to Vesalius's *De Humani Corporis Fabrica* (*On the Fabric of the Human Body*), William Hunter's *Anatomy of the Human Gravid Uterus* (1774), Henry Gray's *Anatomy, Descriptive and Surgical* (1858), and Frank H. Netter's *Collection of Medical Illustrations* (1948) and *Atlas of Human Anatomy* (1989), the history of anatomical illustration reflects a continuous evolution of visualizing the human body.

1.2. Visualizations of medical concepts and processes: exploring medical animations to enhance translation competence

"Medical animation" as a product is typically defined as a short educational film that uses illustration and motion to explain complex medical concepts and help visualize processes that are often difficult to convey—such as disease processes and therapies. Drawing on multiple semiotic modes and communication techniques similarly to cinema and audiovisual translation—including language and specialized terminology, video, audio, motion capture, special effects or VFX, lighting, animation rigging[2], 3D modelling, 3D texturing[3], and 3D rendering[4]—medical animations can be understood

2 "Rigging is the process of creating a digital skeleton for a 3D character model, which animators can then manipulate to create motion." (https://cada-edu.com/guides/rigging).

3 Texture artists are responsible for applying color and surface attributes to 3D objects. The general objective is to make the model's surface match its concept art design or real-world counterpart. For instance, if the model is supposed to represent a brick wall, the task of the texture artist would be making sure the 3D brick wall shares the same color and surface properties of a real-world brick wall when rendered." (https://dreamfarmstudios.com/blog/3d-texturing-in-animation-production/)

4 "3D rendering is the process of producing an image based on three-dimensional data stored on a computer. It is much like photographing or filming a virtual 3D scene. » (https://dreamfarmstudios.com/blog/the-final-step-in-3d-animation-production-3d-rendering/)

as multimodal communication products (Kress 2010). With a specific purpose[5] or *skopos*[6] (Vermeer 1978), they are centered on an intended audience, such as patients, students, health professionals, or researchers. They function as a form of transcreation (Díaz-Millón and Olvera-Lobo 2021), "translating" abstract scientific knowledge into vivid, often cinematic[7] visual narratives, and situating medical content within a specific communicative context. Despite their growing prevalence, medical animations have not yet been widely studied within the field of translation studies. Yet the fact that translation studies has been recognized as a transdiscipline (Abend-David, 2014: xviii), as a field of knowledge that crosses and transgresses other disciplines, makes it particularly well-suited to engage with such multimodal phenomena. Research in audiovisual translation (AVT) has so far concentrated primarily on animated films—such as those produced by Disney, Pixar, DreamWorks, 20th Century Fox, Illumination, and Universal—which have historically targeted children but increasingly attract broader audiences. Translation studies have also considered Japanese anime films (Adachi, 2012). However, neither of these domains has systematically addressed animations dedicated to serious or health-related topics, leaving medical animation largely unexplored as an object of study in translation research.

This gap suggests that medical animation could constitute a particularly rich and new area of research in translation studies, while its role as multimodal content could provide a fruitful focus for investigation in translation didactics. On the one hand, medical animation offers an opportunity to examine how translation strategies used in audiovisual translation (for example, how to describe images or sounds for better media accessibility; how to coordinate on-screen text with images and sound; how to synchronize visual representation with narration) might be applied to multimodal scientific communication, while also addressing practical and methodological issues related to terminology (understanding specialized texts, mapping scientific knowledge, using documentation strategies), adaptation, language accessibility, and content readability. On the other, if translation is metaphorically understood, following Callon and Latour (2006 [1981]), as a process of negotiation and transformation, medical animation could be used in translation pedagogy as an example of the collaborative dimension of the meaning-making and meaning-negotiating processes which take place between disciplines, and within networks composed, in this case, of medical experts, de-

5 They are used for patient education, helping individuals understand care procedures, preventive measures, lifestyle changes, and treatment plans, sometimes incorporating gamification to improve engagement and compliance. They support the training of healthcare professionals, including students and staff. In scientific research and visualization, medical animations illustrate molecular interactions, cellular processes, and biological events. They also aid surgical planning and simulation, allowing surgeons to explore patient anatomy, plan procedures, and rehearse challenging operations safely in a virtual environment.

6 In the field of translation studies, Hans Vermeer (1978) believes that the purpose of a text determines the translation strategies.

7 "We are applying the same tools to science as Hollywood and cinematic visual effects and video games. Science is full of complicated jargon that is very hard to understand. We translate all that science into a visual story, so people can see science unfold without the use of any language or words." (Biomedical animator Drew Berry quoted in Breen 2017: online).

signers, animators, medical illustrators, computer scientists, patients, etc. From a skills development perspective, medical animations could serve as valuable material in translator training, helping build competencies in interdisciplinary and transdisciplinary negotiation, more precisely in the ability to collaborate and integrate knowledge from different disciplines (Mittelstraß, 1987), and the ability to collaborate and integrate knowledge of societal actors or stakeholders (Jahn et al., 2012). So far, the term "negotiation" has been used in translator training to refer to service provision skills[8], to negotiation between social actors governed by the cost-mutual benefits logic (where the costs of producing the translation determines whether translation is justified; Pym, 1995), to intercultural and cross-cultural skills, to the ability to negotiate with technology (such as translation memories), or to negotiation of translation norms between various agents on the production and reception sides (Hu, 2020), but not to interdisciplinary and transdisciplinary negotiation. In discussing the negotiation of adequate rates of pay, Pym (2013: 495) argues that negotiation strategies should be taught and simulated in the classroom, as this can also help develop students' critical awareness. Pym's conceptualization can be extended to the exploration of medical animations as sites where medicine, visual communication, technology, and the humanities must work together and negotiate their own epistemic frameworks which can conflict or diverge. If these skills were to be taught in class, students assuming different roles (physicians, medical illustrators, software developers, etc.) would need to justify their decisions, explain how to compromise on conflicting demands, and communicate disciplinary constraints clearly, an ongoing reflection process that could help them develop strategies to align scientific knowledge, visual representation and audience expectations within a coherent communicative product, while also learning new technological skills.

If translation is "the metaphor for all kinds of processes of transformation, rewriting, encoding and decoding as well as for cross-disciplinary exchanges within humanities and between the humanities and the natural sciences" (Guldin, 2015: 69-70), medical animation embodies this idea perfectly as it presupposes scientific knowledge is transformed, rewritten and encoded into visual representations in a cross-disciplinary exchange where science meets and blends with the humanities. From this perspective, medical animation can be understood as a complex form of intersemiotic translation (Toury, 1986), functioning not only as a bridge between traditionally opposed knowledge fields but also as a process of "translation" between different signifying systems or *Umwelten* (Kull and Torop, 2003), where scientific meaning is transformed from textual description into visual depictions, kinetic representations and storytelling. From this viewpoint, focusing on medical animations as a dynamic mode of knowledge representation, transformation, and dissemination would allow translators to develop or enhance their intermediality skills (interacting with multiple media in one single product

8 "This competence covers all the skills relating to the implementation of translation and, more generally, to language services in a professional context – from awareness of clients, commissioners and users and negotiation through to project management and quality assurance." (European Commission, Directorate-General for Translation, 2022: online).

to create meaning; already discussed in subtitling by De Linde and Kay, 1998) and transmediality skills (understanding meaning communicated across multiple media platforms; see Jenkins, 2006) as medical animations are often integrated, as we will see below, in interactive apps, videos, augmented and virtual reality simulations, 3D deliverables, interactive presentations, and other graphical materials (see, for example, High Impact, 2026), targeting either patients, professionals, or medical students.

Examining medical animations as multimodal content creation can also help translators develop multimodal literacy, where multimodality can be approached from four different perspectives, according to Querol-Julián & Fortanet-Gómez (2025: 5): multimodal social semiotics which explores meaning-making as a social activity, focusing on the importance of the social context (ideologies, social values, power dynamics), also a critical issue in translation; multimodal discourse analysis or "how meaning changes through transemiotizing" (*idem*); multimodal interaction analysis which focuses one how actors interact in specific communicative settings, and multimodal conversation analysis which "centers on the social order in interaction" (how semiotic resources are mutually elaborated, how actions are coordinated and "how coparticipants orient to each other's conduct and assemble it in meaningful ways, moment by moment" [Mondada, 2018: 86, quoted by Querol-Julián & Fortanet-Gómez, 2025: 6]).

Finally, the reflection on translator training through the study of medical animations can be extended to AI-assisted translation and human–machine synergy in general where translators can strategically use AI to complement human knowledge. By interpreting and adapting specialized content for various audiences, students can practice reformulating prompts, enhancing both their translation competence and their ability to guide AI-generated outputs effectively.

Medical animations can range from simple 2D illustrations to highly detailed 3D renderings, depending on the complexity of the content and the intended audience. While Bolaki (2016: 180) defined medical animations in a way that implied medical animations are exclusively 3D, this perspective likely reflects contemporary advances in scientific communication technologies, and the ability of 3D animation to provide highly detailed simulations of anatomical and biological processes and integrate advanced technologies and techniques, such as virtual and augmented reality for immersive experiences, artificial intelligence for content adaptation or gamification for increased users' engagement with scientific narratives and motivation in public health-related topics.

3dforscience (n.d.: online) identifies several distinct categories under the umbrella of "medical animation" primarily focused on serving the medical community, which correlates with the fact that medical animators can choose "specialize by subject matter, such as surgery, veterinary medicine, or ophthalmology […], by media, such as computer animation or the making of three-dimensional models […], [or] by targeting specific markets such as medical publishing, pharmaceutical advertising, or medical-legal work" (AMI 2025: online), in the same way translators can choose to develop subject-specific knowledge (e.g. medical translation), focus on different text media (e.g. subtitling) or target specific client types or industries:

1. Scientific animation – This includes (a) cellular and molecular animations, which explain processes such as DNA function, enzyme activity, and subcellular interactions, as well as (b) mechanism of action (MoA) animations, widely used by pharmaceutical and biotechnology companies to illustrate how drugs, therapies, or biological processes operate at the molecular or cellular level.
2. Branding animation – Designed to generate brand awareness for products in development. If extended to patients, this category could include healthcare marketing animations, which raise awareness about medical conditions, support patient care in hospitals, or explain health issues to the lay viewers, such as how viruses spread.
3. Medical device animation – Used as a training tool for healthcare professionals and customers, demonstrating how a device functions and how to operate it.
4. Surgical and medical procedure animation – used to teach healthcare providers and patients what to expect during procedures.
5. Pharmaceutical technologies and platform animations – These illustrate innovations in areas like genome sequencing, biomarker identification, nanotechnology applications, and advanced drug delivery systems.

Additionally, medical animations are increasingly integrated into health apps, guiding users through home exercises, rehabilitation routines, medication usage, or chronic disease management. This repurposing demonstrates "transmediality" (Jenkins 2006), a process in which core elements of a fictional story (e.g. *how to treat minor burns*) are systematically distributed across multiple media channels, maybe in "novel medicine" or fiction, too (Schonebaum 2016), with the possibility that each medium adds unique understanding to the narrative experience, and could imply, from a translation didactics point of view, the necessity to train translators in interdisciplinary conversation of narrative modes.

Preim and Meuschke (2022: 308) provide a comprehensive and technically nuanced classification of medical animations, not only distinguishing between those derived from static versus dynamic data but also supporting the view that medical animations encompass more than just 3D representations. Animations based on dynamic data use "primary motions", which refer to the movement of actual entities (objects or subjects), for example how a tumor grows or how a contrast agent spreads. Animations based on static data use "secondary motions" which involve camera actions (pan, tilt and dolly), lens effects (zooming) or scene presentations (illumination settings, transparency of structures) (Preim and Meuschke 2022: 307).

Another used term that goes beyond the field of healthcare is "explainer animation" or "animated explainer video", referring to short (less than one minute), animated films designed to concisely de-

redit
Revista Electrónica de Didáctica
de la Traducción y la Interpretación

scribe or demonstrate a product, service, or concept. In the healthcare context, the term denotes narrative-based educational videos created to simplify and quickly visualize complex medical information for lay audiences. Therefore, they prioritize narrative accessibility, comprehension, and engagement over scientific accuracy and jargon, and visual fidelity. Explainer animations can incorporate a range of visual techniques, including 2D and 3D animation, motion graphics, and illustrated sequences. They typically combine visual storytelling, a well-crafted script that outlines the narrative structure, and professional voiceover narration, resulting in engaging and accessible audiovisual communication. As one source notes: "Some people prefer the word 'myocardial infarction,' while others prefer a simpler word like 'heart attack." (Animated Explainers 2025: online).

1.3. The power of storytelling and the need to humanize the medical discourse

Preim and Meuschke (2022) provide a valuable framework for understanding content strategies in medical animation. They distinguish between "scientific animations", grounded in physical laws and aiming for realism—mainly used in research and diagnostics—and "non-scientific animations", which privilege plausibility and aesthetics over accuracy, serving primarily educational and patient-oriented purposes (Preim and Meuschke 2022: 308). They argue non-scientific animation relies on artistic collaboration to enhance engagement and emotional resonance, and that it needs to emphasize narrative as a key component of visual communication. As well, non-scientific animations "aim at a plausible depiction of movements without any guarantee that the behavior is correctly shown" (Preim and Meuschke 2022: 308).

The distinction between scientific animations and non-scientific animations evokes the contrast between the old biomedical model of disease and the new medical models inspired by the humanities. Traditionally, medicine has been dominated by the "biomedical model", which, as Rui et al. (2025: 887) describe, is "disease-centric," viewing health and illness primarily through the lenses of physiology and pathology. Within this framework, disease is understood as originating in the individual's physical body, and treatment is seen as a way to alleviate all symptoms. The patient, who lacks agency, is a passive target of that treatment, and the body is a machine which needs to be fixed, being separated from the mind (non-holistic approach). As well, medical judgements determine what is not normal (Willis and Elmer, 2007; Rocca and Anjum, 2020). Critics such as Bleakley (2015: n.d.) contend that the biomedical model, which contrasts with sociological theories of care, fosters what he calls a "production of insensibility" in medical education—an institutional culture that can desensitize both practitioners and patients. The emerging field of critical medical humanities seeks to counteract this by "redistributing the sensible," that is, by reintroducing empathy, creativity, and knowledge democratization into medical practice and education, which points to both a political and an aesthetic act. Through art, storytelling, and the creative use of language, among others "in the cultural production of prescriptions, drugs, and drug formularies", and by focussing on the core element of medicine, the field of critical medical humanities aims to humanize medicine[9] and challenge inequities embedded within it.

By centering the patient's story and endowing patients with agency, medical animations can better align with audience expectations and enhance communication. Given that medical error ranks as the fourth leading cause of death after cancer, heart disease, and respiratory illness—argues Harmon (2009) —, improving communication through narrative competence, artistic engagement, and digital media mastery remains a vital goal for contemporary medicine. In terms of what the audience prefers as content, Zheng (2016) notes that lay viewers seek familiar visual cues—such as human-like motion and cinematic storytelling—to process abstract biomedical concepts, whereas expert viewers prefer scientifically faithful simulations and may reject over-humanized representations as they would create "a mental state of cognitive dissonance" (Zheng 2016: 5). For general audiences, humor, exaggeration, and aesthetic appeal foster understanding and engagement ("the looks or movements of cells and molecules can be exaggerated to a human-like level", notes Zheng [2016: 98]); for experts, precision and simulation foster insight. Storytelling in patient education thus emerges as a bridge between science with its factual rigor and specialized language, and comprehension—humanizing complex biomedical processes, translating data into experience, and transforming visualizations into meaningful narratives.

Building on the power of narrative medicine and storytelling, Rea (2020) argues that medical animations often overlook fundamental storytelling elements—such as character development and story arc—and underlines the importance of structure as even the most technical visualizations benefit from a coherent narrative backbone. Zheng (2016) also stresses that both experts and lay viewers need a storyline or a backbone, and the script can be adapted "to serve various purposes, such as marketing, selling or education" (Zheng 2016: 45). Rea (2020: 131-133) advocates using storyboards as essential planning tools in the preproduction phase. They help organize ideas, foster collaboration, and infuse the animation with emotion and visual rhythm through cinematic choices—camera angles, lighting, pacing, and transitions—all serving the learner's engagement and retention. As Beane (2012: 25) similarly notes, every 3D animation, regardless of its context, must ultimately "tell a story" by crafting a compelling visual narrative.

9 A major development within this humanistic turn is narrative medicine, pioneered by Rita Charon, professor and founding chair of the Department of Medical Humanities and Ethics and professor of medicine at Columbia University where she also co-chairs the Division of Narrative Medicine. Narrative medicine challenges the traditional subject–object divide of biomedicine by centering the patient's story. Through attentive listening and narrative competence, physicians integrate patients' subjective experiences into diagnosis and care, enhancing empathy and understanding in clinical encounters, while also developing their narrative skills (Rui et al. 2025: 888).

2. STUDY OVERVIEW

2.1. Research motivation

Descriptions of "medical animation" reveal persistent ambiguity when the term is applied to patient-centered audiovisual content. This raises the question: is "medical animation" the most appropriate term for patient education materials? If so, can such animations for patients be considered scientifically rigorous?

When serving professionals—clinicians, researchers, or regulatory bodies, "medical animation" designates scientifically grounded visualizations where accuracy, anatomical fidelity, and technical validation are paramount. Industry leaders in life science visualization and digital media production such as Mad Microbe Studios emphasize that animations for healthcare professionals must be "not only visually stunning but also scientifically sound and ready for regulatory approval," (2025: online) underscoring the importance of factual precision (use of correct terminology and science facts) and adherence to scientific and legal standards. Similarly, Helix Animation (2025: online) emphasizes scientific storytelling, asserting that effective medical animations merge a compelling narrative flow with rigorous scientific accuracy—simplifying complex concepts without oversimplifying them, while maintaining audience engagement. Animations and scripts should be grounded in up-to-date, peer-reviewed scientific literature, and production teams are expected to have experience navigating Medical, Legal, and Regulatory (MLR) reviews. Additionally, the inclusion of medical or scientific experts—such as PhDs, MDs, or specialized consultants—ensures that scientific integrity is embedded throughout the creative process.

By contrast, medical animations targeting patients or lay viewers occupy a different communicative space. Here, aesthetic appeal, emotional engagement, and accessibility often take precedence over strict scientific precision. In such contexts, the focus shifts from demonstrating technical accuracy to fostering understanding and reassurance through narrative simplicity and visual clarity. As a result, these patient-facing materials seem to be closer to what the communication industry describes as "healthcare explainers" or "animated explainer videos".

This distinction raises questions translator training. How should translators handle the balance between scientific accuracy and audience focus or *skopos* when dealing with medical animations as multimodal texts? Which multimodal strategies—verbal and non-verbal—and cross-disciplinary competencies are needed to adapt patient-centered animations for different languages, cultures, and literacy levels, while preserving both educational value and scientific integrity? Which existent content evaluation frameworks in the healthcare field could inform translation theory, practice, or pedagogy? Crucially, (audiovisual or medical) translators do not seem to be mentioned as actors in the production teams of medical animations, despite their expertise in symbolic interpretation, cultural mediation, specialized medical translation, and subtitling, dubbing, or voice-over. The profession should advocate for the integration of translators into these teams to ensure that adaptations account for cultural sensitivities, health literacy, and cross-cultural comprehension—areas where translation studies can make a distinctive and essential contribution.

2.2. Research questions

From this perspective, this study aimed to investigate how research on medical animation in the healthcare field addresses patient education. Key questions include: Is patient-focused medical animation exclusively 3D, or does it also encompass simpler, non-scientific instructional formats? How is the concept of patient-centered medical animation most often defined or labeled across studies? To what extent do such animations prioritize narrative accessibility and aesthetic engagement over strict scientific precision? Last, but not least, what criteria, if any, are being used for content evaluation?

To explore these questions, we examined publications indexed in PubMed, the leading biomedical research database maintained by the National Institutes of Health (NIH), with attention to how they address content adaptation, narrative framing, and stylistic humanization for lay audiences. We also reviewed the evaluation frameworks employed, including measures of clarity, accuracy, usability, cognitive load, effectiveness, and overall pedagogical quality.

2.3. Findings

2.3.1. Literature on animation for patient education and the extent of content evaluation

To obtain a general overview of the literature on animation in a medical context, as reflected in PubMed, we conducted a broad search using multiple relevant terms, which retrieved a total of 257 articles. Some of these results likely addressed animation only tangentially and did not appear directly relevant to medical animation. To refine the scope and gain a more focused understanding of how content is evaluated medical animation, we expanded the original query by incorporating additional specific keywords connected with the OR operator while also adding the names of health information scores (DISCERN, JAMA, PEMAT, LIDA, Suitability Assessment of Materials [SAM]) and of readability scores (Flesch Reading Ease Score, Flesch-Kincaid Grade Level, SMOG Index, Gunning Fog Index, and Coleman-Liau Index)[10]. The research yielded 22 articles (8,56%) out of which only 6 focused on animated videos (rather than on videos or Websites with animation).

10 Final search query was: ((“patient education” OR “patient information” OR “patient instruction” OR “patient teaching” OR “patient training”)
AND
(animation OR animations OR “medical animation” OR “medical animations” OR “video animation” OR “video animations” OR “healthcare animation” OR “animated videos” OR “animation-enhanced videos” OR “animation education” OR “digital animation” OR “3D animation” OR “3D animations” OR “animation-supported communication”)
AND
(“content evaluation” OR “content assessment” OR “content validation” OR “content quality” OR “content score” OR “content accessibility” OR “content usability” OR “content suitability” OR “content accuracy” OR “content acceptability” OR “quality score” OR “usefulness score” OR “understandability score” OR “information load” OR “textual clarity” OR “reading ease score” OR DISCERN OR JAMA OR PEMAT OR LIDA OR “Suitability Assessment of Materials” OR SAM OR “Flesch Reading Ease Score” OR “Flesch-Kincaid Grade Level” OR “SMOG Index” OR “Gunning Fog Index” OR “Coleman-Liau Index”))

-Summary of key findings (for details, see Table 1 in the Annex)

The six articles reviewed assess patient-oriented animations using several key criteria and not necessarily all of them. On the language/terminology side (how information is expressed), they emphasize comprehension, clarity, understandability, accessibility and accuracy. On the communication side (how information is transmitted; how content reach is measured), the focus is on engagement (popularity metrics) and the effectiveness of the medium. The accountability and reliability criteria span both language and communication, since they depend on what is said and how it's conveyed. In terms of content planning, the studies underline the importance of involving a multidisciplinary team. Finally, regarding the perlocutionary effects of the content, the articles evaluate the usefulness and practical impact of the animations. Overall, the criteria used focus more on patient-centered animations as communication tools and less on patient-centered animations as outputs involving scientific collaboration and validation.

2.3.2. Literature on 3D animation for patient education and the extent of content evaluation

Another targeted search was conducted in PubMed to explore the role of 3D animation in patient education[11]. This search yielded a total of 14 articles. After excluding 1 article in German and 3 irrelevant articles, 10 articles were deemed relevant[12]. Notably, none of the selected studies explicitly focused on the evaluation of content quality—highlighting a gap in the literature concerning how 3D patient education materials particularly are assessed for accuracy, usability, or effectiveness beyond knowledge retention or user feedback.

- Summary of Key Findings

Across the reviewed studies, 3D animations consistently enhance patient education and engagement compared to traditional materials such as leaflets, printed texts, or verbal explanations. Animations improve knowledge recall and retention, particularly when paired with narration or interactive features (2014a, 2016, 2023). For low health literacy audiences, 3D animations are considered to pro-

11 Query: ("patient education" OR "patient information" OR "patient instruction" OR "patient teaching" OR "patient training") AND (("3D animation") OR ("3D animations") OR ("3-dimensional computer animation") OR ("3-dimensional computer animations") OR ("three-dimensional computer animation") OR ("three-dimensional computer animations"))

12 The effectiveness of video animations as information tools for patients and the general public: A systematic review (2022); Role of 3D animation in periodontal patient education: a randomized controlled trial (2014a); Efficacy of three-dimensional visualization in mobile apps for patient education regarding orthognathic surgery (2016); Does Multimedia Education with 3D Animation Impact Quality and Duration of Urologists' Interactions with their Prostate Cancer Patients? (2015); A comparative assessment of information recall and comprehension between conventional leaflets and an animated video in adolescent patients undergoing fixed orthodontic treatment: A single-center, randomized controlled trial (2021); Effect of 3D Animation Combined with Teach-Back Health Education on Pelvic Floor Muscle Training in LARS Patients: A Randomized Controlled Trial (2023); Effectiveness of 3D animation tools in patient education on cochlear implantation (2025); Digital multimedia books produced using iBooks Author for pre-operative surgical patient information (2014b); CardioOp: an integrated approach to teleteaching in cardiac surgery (2000); Seeing the doctor without fear: www.doctortea.org for the desensitization for medical visits in Autism Spectrum Disorders (2017).

mote (2022) surface-level learning and to have limited viewer attention for complex subjects. As a result, animations intended for lay viewers are perceived to be most effective when used to deliver introductory or overview content, rather than in-depth instruction. Some studies found no significant improvement in objective knowledge despite higher self-reported understanding (2025). As regards popularity, 3D animations are perceived as more engaging and satisfying than traditional methods, especially among younger patients (2021), and they are known to reduce the need for patients to seek external information (2014b), which helps ease anxiety (2017). 3D animations improve the quality of doctor–patient interactions without extending consultation time (2015). Combining 3D animation with teach-back education enhances both skill mastery and symptom reduction in specific clinical contexts where patients need to be trained (2023). One study highlights the need for content customization to accommodate different user levels (2000).

2.3.3. A few more statistics regarding medical animations and content assessment

It is only when expanding the search to "medical animation(s)" focussed on patients rather than patient-centered "3D animations" that we find slightly more results (18 articles). However, only three of these articles were deemed relevant to the domains of patient education and the application of communication strategies in the design of medical animations. One article[13] focussed on medical students, but the authors suggested its conclusions are applicable to broader audiences. By employing storytelling through animation, the study found that engagement and retention significantly increased. One less recent article [14]revealed that many animations failed to adhere to core multimedia learning principles as outlined in the cognitive theory of multimedia learning (CTML), particularly those related to managing essential cognitive processing (overuse of extraneous visual and auditory elements, and limited interactivity; however). A more recent study[15] found that most animations only adhered to four out of eleven principles, namely coherence, redundancy, modality, and spatial contiguity. However, animations that were rated most enjoyable and effective did not necessarily follow more learning principles than lower-rated ones, which suggests a disconnect between design quality and perceived effectiveness.

When searching for "scientific animation*", we extracted a total of five results, with only one article specifically addressing health-related animations intended for the lay viewers[16]. A search for "molecular animation*" returned 18 results, all of which were aimed at students in the medical field. Searches for "branding animation" and "marketing animation*" returned no results. There were no results for the search term "non-scientific animation*"; however, a search for "educational

13 Animated stories of medical error as a means of teaching undergraduates patient safety: an evaluation study (2019).

14 Applying the cognitive theory of multimedia learning: an analysis of medical animations (2013).

15 Is a Picture Worth a Thousand Words? Evaluating the Design of Instructional Animations in Veterinary Education (2020).

16 Measuring the impact and reach of informal educational videos on YouTube: The case of Scientific Animations Without Borders (2021).

animation*" yielded 27 results. Several of these articles focused on patient education and addressed issues such as the need to have content validated by subject matter experts[17], the benefits of content accessibility[18], the advantage of a multidisciplinary team for customizing content[19], or the importance of using culturally targeted content strategies[20]. Animations were considered "effective" if visually engaging, providing clear but also manageable content (short, segmented video formats made learning more digestible), if using relatable characters and emotionally resonant scenes, and if empowering patients by dispelling myths, clarifying misunderstandings and introducing new concepts; beyond cognition, they had to deliver the content through multiple channels and be broadly shareable (with family, friends, and social circles to enhance awareness and support) (*idem*). One last study[21] evaluated educational animations by analysing their visual attractiveness and emotional appeal (relatable characters), content quality (practical messages, impact, segmented content, content addressing everyday concerns), content acceptability (credibility but also alignment with audience's values), content customization (conversational style, concise sentences, and common vocabulary for lower-literacy audiences; progressive introduction of more complex concepts), anticipated usability with a larger group (shareability on various platforms and in different formats), and knowledge recall optimization by using synchronized audio and visual stimuli. The study also stressed the necessity to have a multidisciplinary team already from the conceptualization phase.

3. CONCLUSION

The analysis of PubMed-indexed publications reveals a fragmented landscape in the study of medical animation for patient education in the field of health care. The ambiguity persists regarding the terminology used to define this type of content: while the term "educational animation" is more frequently employed when referring to materials aimed at patients (more results have been extracted when performing a search with this term), "medical animation" and "scientific animation" seem to be rather reserved for professional or instructional contexts. In many cases, animation is not the central focus of investigation but rather a secondary component embedded within broader audiovisual materials. No specific study in PubMed draws on theoretical frameworks from translation studies to examine animations as acts of translation, adaptation, or transcreation, with one single study indicating the necessity to have subtitles in different languages. Although some studies explicitly assess the quality of animated content by focusing on language, communication, content planning, and content

17 Educational animation about home care with premature newborn infants (2018).

18 Including the patient in patient blood management: Development and assessment of an educational animation tool (2023).

19 Developing Educational Animations on HIV Pre-exposure Prophylaxis (PrEP) for Women: Qualitative Study (2022).

20 Patient perceptions by race of educational animations about living kidney donation made for a diverse population (2022).

21 Development of the living donation and kidney transplantation information made easy (KidneyTIME) educational animations (2020).

impact and actionability (perlocutionary effect) criteria, the literature within the scope of PubMed remains limited in its systematic evaluation of design methodologies and content accuracy. Only a small subset of publications explicitly applies established assessment tools or standardized content quality scores to animations.

Some studies also show animations are built on validated content, often co-designed with patients and experts. Incorporating relatable characters, storytelling elements, and emotional cues further enhances viewer engagement, especially for lay audiences. Overall, the criteria used focus more on patient-centered animations as communication tools and less on patient-centered animations as outputs involving scientific collaboration and validation, which suggests the conceptual boundary between scientific animation and educational animation remains blurred, and also raises questions regarding how (audiovisual) translators specializing in medical animation could be trained to be able to adapt content by crafting a compelling visual narrative while preserving scientific accuracy and multimodal coherence. To advance the current state of research, future studies could develop cross-disciplinary criteria from communication, translation (including terminology, audiovisual translation, media accessibility), multimedia learning, arts and science, combined with approaches from medical humanities, to strengthen the scientific validity and broaden the communicative impact of medical animations in patient education.

From a translation didactics perspective, medical animations highlight the need for the development of interdisciplinary pedagogy that combines theoretical knowledge and practices from diverse disciplines, such as the sciences and the humanities. Such an approach can help build negotiation skills when interacting with divergent or creative ways of thinking and making (for example, AI, but not only), enabling translators to anticipate steps in the negotiation process and organize their actions accordingly.

In the same way that medical discourse needs to be humanized through the power of storytelling, translation as a humanistic discipline has much to learn from medical science, technology, and the arts. Through the scientific dimension of medical animations, translators can develop pragmatic rigor, analytical thinking, literacy in modes of technical representation (which is also valuable for terminology work), and effective research strategies. From the arts, translation can strengthen their ability to engage with nonverbal, non-textual, or non-human phenomena, drawing on situated and sensorial experiences across multiple platforms. Engagement with the arts can also reveal how ‘translation’ goes beyond the mere passing of information and words, functioning instead as a process that creates a rich network of isotopies in the viewer’s mind and eyes, and thereby stimulating active critical thought. Finally, by engaging with different fields and stakeholders, translators may also learn to ask the right questions and act in an ethically responsible manner.

REFERENCES

3DforScience. (n.d.) Types of Medical Animation, https://3dforscience.com/blog/medical-marketing/types-of-medical-animation/

Abend-David, D. (ed.) (2014). *Media and Translation: An Interdisciplinary Approach*, New York: Bloomsbury Academic.

Adachi, R. (2012). *A study of Japanese animation as translation: A descriptive analysis of Hayao Miyazaki and other anime dubbed into English*. Universal-Publishers.

Animated Explainers. (2025). Industry-driven impactful animations. Animation for healthcare and medical, https://www.animatedexplainers.com/healthcare-explainer-videos.

Association of Medical Illustrators. (2025). Learn About Medical Illustration, https://www.ami.org/medical-illustration/learn-about-medical-illustration.

Beane, Andy. (2012). *3D Animation Essentials.* Indianapolis: John Wiley & Sons.

Bleakley, Alan. (2015). *Medical Humanities and Medical Education. How the Medical Humanities Can Shape Better Doctors.* Abingdon and New York: Routledge.

Bolaki, Stella. (2016). *Illness as Many Narratives: Arts, Medicine and Culture.* Edinburgh: Edinburgh University Press.

Breen, Fiona. (2017, May 29). Biomedical Animator Drew Berry Brings Together Art, Science, and a Bit of Björk. *The Sydney Morning Herald*, https://www.smh.com.au/entertainment/vivid-ideas-biomedical-animator-drew-berry-brings-together-art-science-and-a-bit-of-bjork-20170529-gwfg5b.html.

Callon, M. and Latour, B. (2006 [1981]). « Le grand Léviathan s'apprivoise-t-il? » In Madeleine Akrich, Michel Callon and Bruno Latour, ed. *Sociologie de la traduction. Textes fondateurs*. Paris, Presses de l'École des Mines, p. 11-32.

De Linde, Z. & Kay, N. (1998). *The semiotics of subtitling*. Manchester, NH: St Jerome Publishing.

Díaz-Millón, Mar and María Dolores Olvera-Lobo. (2021). Towards a definition of transcreation: a systematic literature review. *Perspectives* 31 (2): 347-364.

European Commission, Directorate-General for Translation. (2022). *European Master's in Translation: Competence framework 2022.* European Commission. https://commission.europa.eu/document/download/b482a2c0-42df-4291-8bf8-923922ddc6e1_en?filename=emt_competence_fwk_2022_en.pdf.

Fu, C., Feng, X., Huang, Y., Huo, W., Li, B., Xiang, Y., ... & Liu, T. (2026). Ensuring Consistency for In-Image Translation. *Mathematics*, *14*(3), 490.

Guldin, Rainer (2015). Translation as a metaphor in psychoanalysis, anthropology and ethnography, postcolonial theory, history and literature. In *Translation as a Metaphor*, London and New York. Routledge, p. 69-93.

Harmon, K. (2009, August 10). Deaths from avoidable medical error more than double in past decade, investigation shows. *Scientific American Blog*, https://www.scientificamerican.com/blog/news-blog/deaths-from-avoidable-medical-error-2009-08-10/.

Helix Animation. (2025) Helix's Blog & News, https://www.helixanimation.com/blog.

High Impact. (2026). *High Impact.* https://www.highimpact.com/.

Hu, B. (2020). How are translation norms negotiated? *Target: International Journal of Translation Studies*, 32(1), 83-122.

Jahn, T., M. Bergmann, F. Keil. (2012). Transdisciplinarity: Between mainstreaming and marginalization. *Ecological Economics*, 79, 1-10.

Jenkins, Henry (2006). *Convergence Culture*. New York, London: New York University Press.

Johns Hopkins University, School of Medicine. (2025). Department of Art as Applied to Medicine at Johns Hopkins University, https://medicalart.johnshopkins.edu/.

Kędra, J. (2018). What does it mean to be visually literate? Examination of visual literacy definitions in a context of higher education. *Journal of Visual Literacy*, *37*(2), 67-84.

Kress, Gunther. (2010). *Multimodality: A Social Semiotic Approach to Contemporary Communication.* Abingdon and New York: Routledge.

Kull, Kalevi and Torop, Peeter (2003). Biotranslation: Translation between Umwelten. In *Translation Translation,* ed. by Susan Petrilli, 315-328. Amsterdam: Rodopi.

MadMicrobe Studios. (2025). Medical Animation, www.madmicrobe.com/medical-animation/.

Medical 3D Animation Company. (2025). Biomedical 3D Animations, https://medical3danimationcompany.com/biomedical-3d-animations.

Miller, Jon D. and Linda G. Kimmel. (2001). *Biomedical Communications: Purpose, Audience, and Strategies.* San Diego, San Francisco, New York, Boston, London, Sydney and Tokyo: Academic Press.

Mittelstraß, J. 1987. Die Stunde der Interdisziplinarität? In: *Interdisziplinarität: Praxis, Herausforderung, Ideologie*. Edited by J. Kocka. Frankfurt am Main: Suhrkamp, 152-158.

Netter, Francine Mary and Gary E. Friedlaender. (2014). Frank H. Netter MD and a brief history of medical illustration. *Clinical Orthopaedics and Related Research* 472 (3): 812-819.

Pérez-González, L. (2019, December 31). *Translation and Multimodality: Beyond Words (2020).* https://luisperezgonzalez.org/translation-and-multimodality-beyond-words-2020/.

Peter MacCallum Cancer Centre. (2025). Biomedical Animation, https://www.petermac.org/research/research-support-services/biomedical-animation.

Preim, Bernhard and Monique Meuschke. (2022). Corrigendum. A survey of medical animations. *Computers & Graphics* 107: 304-328.

Pym, A. (1995). Translation as a transaction cost. *Meta: Journal des traducteurs / Meta: Translators' Journal*, 40(4), 594-605.

Pym, A. (2013). *Translation skill-sets in a machine-translation age*. Meta, 58(3), 487-503.

Querol-Julián, M., & Fortanet-Gómez, I. (eds.). (2025). *Multimodal literacy in English as an additional language in higher education*. Taylor & Francis.

Rea, Paul M. (ed.) (2020). *Biomedical Visualisation: Advances in Experimental Medicine and Biology,* volume 6. Switzerland: Springer International Publishing.

Rocca, Elena and Rani Lill Anjum. (2020). Complexity, Reductionism and the Biomedical Model. In R. L. Anjum, S. Copeland, and E. Rocca (eds) *Rethinking Causality, Complexity and Evidence for the Unique Patient*, 75-94. Cham: Springer.

Rui Zhang, Liang Xu, Jiaxin Li and Lili Wang. (2025). The Innovative Education of Cross-Disciplinary Integration of Narrative Medicine with Medical Animation: Exploring the Potential of Health Humanities. *Journal of Sichuan University (Medical Sciences)* 56 (3): 887-892.

Schonebaum, A. (2016). *Novel medicine: Healing, literature, and popular knowledge in early modern China*. Seattle and London, University of Washington Press. https://uw.manifoldapp.org/projects/novel-medicine.

Statistics Canada. (2024, July 23) 51.2703 - Medical illustration/medical illustrator. Classification of Instructional Programs (CIP) Canada 2021, https://www23.statcan.gc.ca/imdb/p3VD.pl?Function=getVD&TVD=1420413&CVD=1420923&CPV=51.2703&CST=15052022&CLV=3&MLV=3.

St-Jean, E. (1996). *Translation and visual communication: Case study of a hospital information leaflet*. Master thesis, University of Ottawa (Canada).

Toury, G. (1986). Translation. In: Sebeok, Thomas (ed.), Encyclopedic Dictionary of Semiotics, vol. 2. Berlin: Mouton de Gruyter, 1107-1124.

University of Toronto. (2025). About BMC, https://bmc.med.utoronto.ca/about-the-program.

Verma, C. S., Rajesh Purohit, Koyen Datta Gupta, and Harsha Verma. (2024). *Computer Graphics and CAD.* Delhi: Manakin Press.

Vermeer, Hans Josef. (1978). "Ein Rahmen für eine allgemeine Translationstheorie." *Lebende Sprachen* 23 (3): 99-102.

Willis, Karen and Shandell Elmer. (2007). *Society, Culture and Health: An Introduction to Sociology for Nurses.* Sydney, Australia: Oxford University Press.

Zheng, Chenlin. (2016). *Visual Consonance: An Analytical Framework for 3D Biomedical Animation.* Unpublished Doctoral Thesis. Queensland University of Technology, Brisbane.

ANNEX

Table 1. PubMed – Summary of Findings from Studies Evaluating the Content of Medical Animations Designed for Patients

Study	Criteria used to assess animations for patients
Effect of Perioperative Patient Education via Animated Videos in Patients Undergoing Head and Neck Surgery: A Randomized Clinical Trial	**LANGUAGE** • Comprehension and Clarity - Ease of understanding the content. - Appropriateness of reading level (6th-grade level). • Accessibility - Availability in multiple languages (English and French), with subtitles in the 20 most spoken languages in the country. **COMMUNICATION** • Acceptability and Engagement - Acceptable, attention-grabbing, and interesting videos. • Medium Effectiveness - Perception of 2D animation as an effective method for conveying medical information. **CONTENT PLANNING** • Content Development and Multidisciplinary Input - Collaboration with a multidisciplinary team. - Coverage of both clinical/surgical aspects and psychosocial dimensions (mental health, family life during recovery). **PERLOCUTIONARY EFFECT** - Perceived usefulness for understanding the medical condition. - Confidence in managing the diagnosis after viewing (impact on self-efficacy). - Likelihood of sharing information with others.
Assessing of the audiovisual patient educational materials on diabetes care with PEMAT	**LANGUAGE** • Understandability and accessibility – Measures how well users from diverse backgrounds and literacy levels can process and explain key messages: - Clear purpose and focused content. - Clear presentation of numbers without requiring calculations. - Logical organization with chunked information and informative headers. - Effective visual aids that reinforce content. - Use of plain language for explaining medical terms. - Use of active voice. - Use of visual cues and easy-to-read text.

	PERLOCUTIONARY EFFECT • Actionability – Measures whether users can identify and take practical steps based on the information: - Clear identification of actionable steps. - Directly addressing the user when describing actions. - Breaking down actions into manageable steps. - Providing tangible tools (checklists, planners). - Simple instructions for calculations if needed. - Guidance on using charts or visuals to perform actions. - Use of visual aids to facilitate completing tasks. - 14 out of 34 materials scored zero for actionability, highlighting a gap in guiding users to take practical steps.
Evaluation of the understandability, actionability and reliability of YouTube videos for brain, head, and neck cancer information	**LANGUAGE** • Understandability - Animated and narrated videos achieved the highest scores. - Clear explanations using visuals to support comprehension. • Reliability (accuracy, trustworthiness, and evidence-based content) - Professional transcripts and peer-reviewed sources improved reliability. - Avoidance of misleading or false information. **COMMUNICATION** • Engagement - Engagement-enhancing elements (animation, narration). **PERLOCUTIONARY EFFECT** • Actionability - Videos with professional transcripts scored higher. - Instructions or guidance were easier to follow when clearly structured.

Assessment of the Quality and Reliability of the Information on Rotator Cuff Repair on YouTube	**LANGUAGE AND COMMUNICATION** • Reliability (DISCERN Questions 1–8) - Clarity of aims: Are objectives clearly stated? - Achievement of aims: Are objectives fulfilled? - Relevance: Is information pertinent to viewers? - Source transparency: Are sources cited? - Currency: Is publication date provided? - Balance and bias: Is information presented objectively? - Additional support: Are supplementary sources included? - Acknowledgment of uncertainty: Are areas of uncertainty discussed? • Accountability / Credibility (JAMA Benchmarks) - Authorship: Authors and contributors with affiliations and credentials listed. - Attributions: References clearly stated. - Disclosure: Relevant disclosures provided. - Currency: Dates of updates or publication included. **LANGUAGE AND PERLOCUTIONARY EFFECT** • Quality of Information (DISCERN Questions 9–15). - Mechanism of action: Are treatments explained? - Benefits: Are positive outcomes described? - Risks: Are potential risks or side effects detailed? - Consequences of no treatment: Are outcomes of no treatment explained? - Impact on quality of life: How might treatments affect daily living? - Alternative options: Are other viable treatments presented? - Support for shared decision-making: Does content facilitate collaborative choices? **COMMUNICATION** • Engagement and popularity - Popularity metrics: Video Power Index (VPI), view ratio, number of views, likes, dislikes. - Animated videos were more popular (higher VPI) but had lower quality scores (DISCERN, JAMA, RCSS). - Shorter videos gained higher engagement, whereas longer videos correlated with better educational content. - Physician-produced videos scored highest in quality but were less popular than patient- or commercially-uploaded videos. • *Key Insights:* - There is a trade-off between educational quality and viewer engagement: entertaining or simplified content is more popular, but often less reliable.

Tumor Immunotherapy-Related Information on Internet-Based Videos Commonly Used by the Chinese Population: Content Quality Analysis	**LANGUAGE** • Quality of Information (DISCERN) - Assessed reliability, accuracy, and comprehensiveness of content (moderate to poor quality observed in most videos, while videos with physicians had higher DISCERN scores). **COMMUNICATION** • Engagement / Popularity Metrics - Forwarding/sharing numbers used as proxy for dissemination. - Physician-led videos not only more reliable but also shared more widely. • *Key Insights:* - Health-related animations are moderately popular but vary in reliability and quality. - Featuring healthcare professionals improves both accuracy and dissemination. - Even when animations are used, professional input is critical for trustworthy patient education. **LANGUAGE AND COMMUNICATION** • Accountability / Credibility (JAMA Benchmarks) - Authorship, attributions, disclosures, and currency evaluated. - Videos featuring doctors more reliable and less likely to contain misinformation. • Misinformation Assessment - Only 12 out of 33 animations contained misinformation. - Physician-led content significantly reduced misinformation.
YouTube provides poor information regarding anterior cruciate ligament injury and reconstruction	**LANGUAGE** • Quality of information - YouTube provides poor information regarding ACL injury and reconstruction. - Quality and accuracy often sacrificed for popularity. **COMMUNICATION** • Engagement / Popularity Metrics - Number of views, likes, and video duration analyzed. - Animated videos strongly correlated with higher number of views. - Shorter videos more likely to be viewed.