

## EXPLORATION OF ENGINEERING TECHNIQUES IN NEUROSURGERY IN ACCORDANCE WITH INTELLECTUAL PROPERTY PROTECTION

**Dan Theodor ANDRONIC<sup>a</sup>, Maria POPA<sup>b</sup>, Constantin OPREAN<sup>c</sup>, Aurel Mihail TITU<sup>c\*</sup>**

<sup>a</sup>National University of Science and Technology Politehnica Bucharest, Romania

<sup>b</sup>1 Decembrie 1918 University of Alba Iulia, Romania

<sup>c</sup>Lucian Blaga University of Sibiu, Romania

---

### ABSTRACT

*The continuous evolution of medical technology has significantly advanced the field of neurosurgery, allowing for more precise and less invasive procedures. This paper presents current exploratory capabilities in neurosurgery and examines potential future developments within modern medicine's intellectual property (IP) principles. The integration of cutting-edge technologies has revolutionised neurosurgical practices, improving diagnostic capabilities and therapeutic interventions. This study highlights the synergy between innovative exploratory techniques and established neurosurgical methods by analysing these technologies to improve patient outcomes and procedural efficiency. Additionally, the role of intellectual property rights in stimulating innovation, while promoting ethical standards and facilitating knowledge exchange, is examined. The balance between protecting technologies and ensuring accessibility for research and development is essential to encourage progress. Emphasis is placed on the implications of IP in facilitating collaborative efforts between researchers, practitioners, and technology developers. By adhering to IP principles, the healthcare field can achieve improvement while maintaining ethical considerations and patient safety, ultimately transforming the "landscape" of modern neurosurgery. This research advocates for policies that support innovation-friendly environments, ensuring that emerging technologies are effectively integrated into clinical practice while respecting both the intellectual contributions of innovators and the universal right to advances in health.*

**KEYWORDS:** *Neurosurgery, innovation, intellectual property, medical technology, collaboration.*

**DOI:** 10.24818/IMC/2025/02.09

---

### 1. INTRODUCTION

The advancement of medical technology used in neurosurgery has resulted in many new procedures that are less invasive, thanks to improved exploratory techniques. These innovations are safeguarded by intellectual property rights (Schulz, Waldeck, & Mauer, 2012). From a scientific perspective, these developments should be seen not in isolation but as part of a complex ecosystem that integrates basic research, clinical practice, and legal regulations concerning patents (World Intellectual Property Organisation, n.d.).

The ethical aspect remains crucial, as the use of advanced technologies must be linked to patient safety and fair access to treatment (Stiglitz, 2008). Progress in biomedical engineering and biotechnology, including three-dimensional computer modelling and robotic systems integration

---

\*Corresponding author. E-mail address: [mihail.titu@ulbsibiu.ro](mailto:mihail.titu@ulbsibiu.ro)

(Cole et al., 2023; Calixte et al., 2023), has fostered the development of minimally invasive techniques.

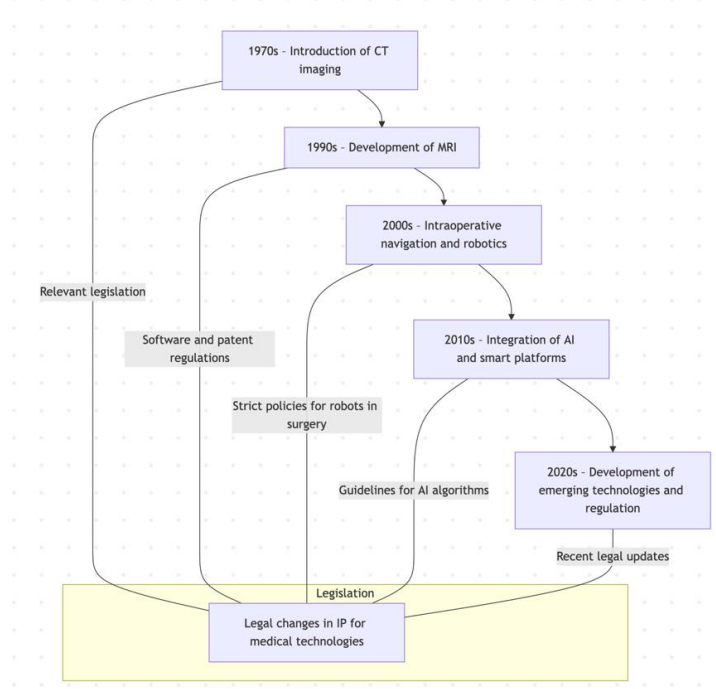


Figure 1. This timeline illustrates the evolution of technological advances in neurosurgery, from the introduction of CT imaging in the 1970s to state-of-the-art systems involving robotics and AI in recent years. Critical legislative changes in IP law have facilitated innovation while managing ethical concerns and access. This sequence highlights the synergy between technological progress and legal frameworks in modern neurosurgery.

*Source: own contribution*

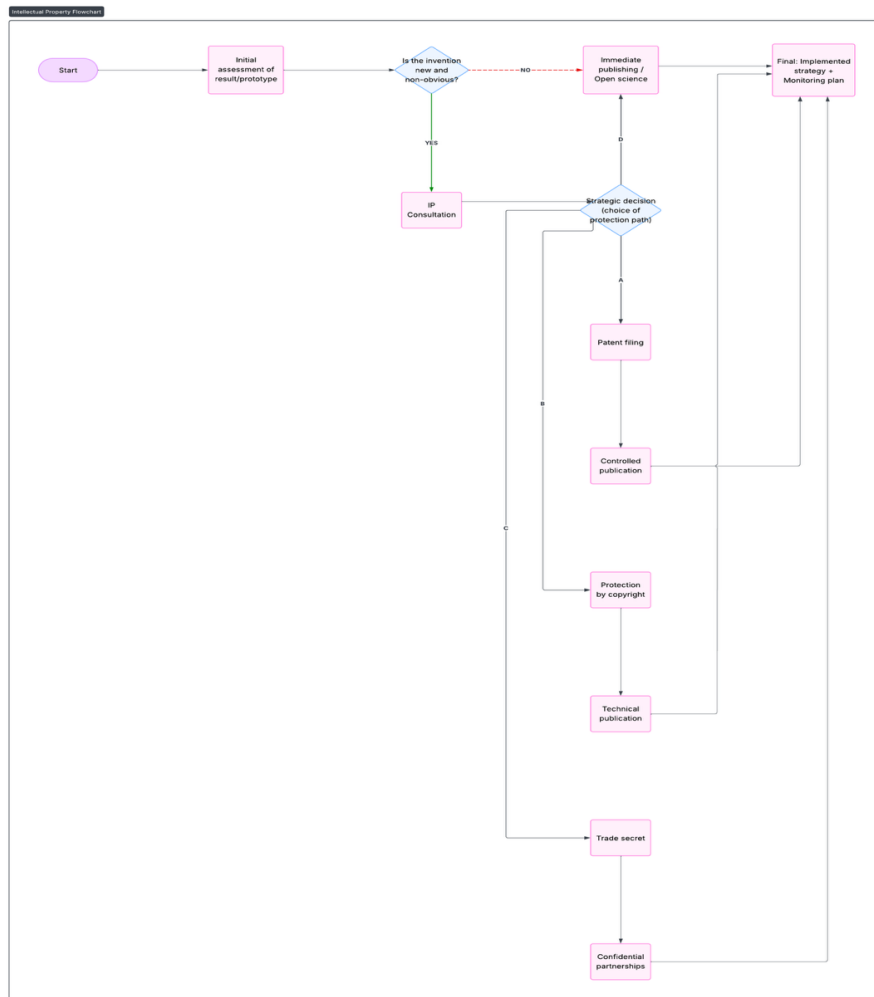
These procedures often originate from collaborative research projects bringing together specialists in neuroscience, medical hardware and software engineering, as well as imaging analysis experts; such collaborations are shaped by economic incentive mechanisms and intellectual property policies (Shavell & Van Ypersele, 2001; Davis, 2004).

Legal protection through patents encourages innovation, prevents unauthorised copying, and guarantees the recovery of investments (Stiglitz, 2008). However, there is an inherent tension between the desire to safeguard results and the need for rapid dissemination to speed up clinical development—publication delays caused by legal or commercial considerations are noted in the literature (Biasi & Moser, 2020).

As seen in the practice of patenting medically relevant genetic or biological sequences, partial publication before filing an application can serve as a legal strategy to prevent rejection on grounds of lack of originality; similar practices also occur in the field of medical devices, based on proprietary algorithms or integrated intraoperative robotic assistance platforms (Titu & Andronic, 2023; United States Patent and Trademark Office, 2024).

The result is a regulatory framework where researchers must decide how to allocate their resources to maximise clinical impact and legal value (United States Patent and Trademark Office, 2023). Evidence from biomedical academic communities suggests that publication delays may occur for legal or commercial reasons related to intellectual property protection; in many cases, senior academics delay publication until patent litigation concludes (Biasi & Moser, 2020; Litman, 2018). This delay may temporarily hinder scientific progress, but it is viewed as a precautionary step. There is a strong argument for early communication of results in advanced neurosurgical research,

especially when they directly impact surgical safety; a balanced strategy would involve sharing key elements for methodological reproducibility and independent verification, while safeguarding technical details that could later be included in a patent application (Litman, 2018; United States Patent and Trademark Office, n.d.).



**Figure 2. This diagram illustrates the decision pathway for researchers deciding between immediate publication and IP protection. The steps involve initial assessment, novelty analysis, IP consultation, and a strategic choice among filing a patent, protecting software via copyright, maintaining trade secrets, or publishing/open sourcing.**

*Source: own contribution*

In many complex clinical situations, evaluating a technology involves more than just assessing its technical functionality; it also includes analysing how it integrates into the existing workflow. Studies on the adoption of new technologies reveal notable differences between professional groups: younger professionals are more likely to quickly adopt new tools than experienced personnel, who tend to prefer technical assistance or pilot periods in use (Tyskbo & Sergeeva, 2022).

This dissonance can affect the effective clinical application of a patented technology. An important aspect is the interdisciplinary collaboration between technology developers and practitioners to adjust technical parameters to the biological and physiological constraints specific to the human brain, to prevent introducing additional risks for patients (Schulz et al., 2012; Cole et al., 2023).

At the same time, patent protection must be designed so as not to hinder independent initiatives to verify and improve the developed systems; comparative evaluations and post-market studies are essential for long-term safety and effectiveness (United States Patent and Trademark Office, 2023).

**Table 1.** The table summarises the official costs and estimates operational costs for various IP protection mechanisms applicable to medical technologies, along with benefits for the innovator and effects on access. Exact values for patent fees and examination durations were taken from the USPTO Fee Schedule and USPTO Pendency Dashboard. Fees and durations for copyright originate from the U.S. Copyright Office guidelines. Observations regarding the impact on access and benefits are based on economic and policy literature on IP and sources applied in medical imaging and IP.

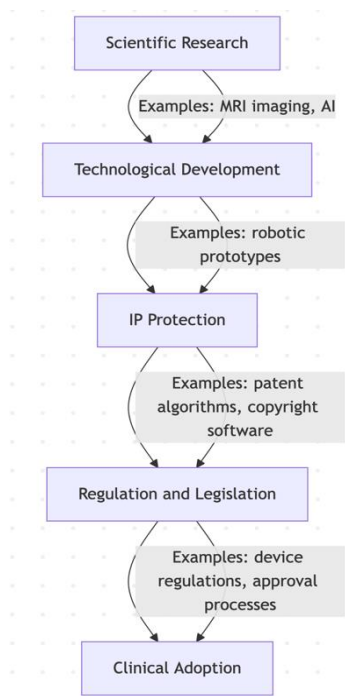
Type of Protection	Estimated Cost (fees, time)	Benefit for Innovator	Impact on Access
<b>Patent</b>	USPTO fees (filing/examination) for micro/small/large entities: \$100–\$730 (filing) + \$180–\$820 (search) + \$160–\$760 (examination) → total initial official fees approximately \$440–\$2,310; lawyer/agent fees: \$5,000–\$25,000+; maintenance fees at 3.5/7.5/11.5 years: \$400–\$3,700; average examination time (pendency): ~18–24 months (United States Patent and Trademark Office, 2023).	Exclusive protection (~20 years from filing), right to exclude third parties, licensing and monetization possibilities; attracts investors; R&D recovery.	May restrict initial access (costs/licenses), can create a temporary monopoly; facilitates controlled transfer via licensing; high costs may limit adoption in resource-constrained centers (United States Patent and Trademark Office, 2023; Stiglitz, 2008).
<b>Copyright (software, docs)</b>	U.S. Copyright Office – Electronic registration: \$45 (single author, single work) or \$65–\$85 (standard electronic filing); processing time: a few days–months (U.S. Copyright Office, n.d.-b).	Protects source code and expression; registration offers procedural advantages in litigation; low registration costs; automatic protection upon creation.	Limited protection of expression; allows functional competition (other implementations may exist); more favorable for access compared to patents; may restrict reuse of proprietary code (Biasi & Moser, 2020; U.S. Copyright Office).
<b>Trade Secret</b>	No official fees; estimated internal administrative costs: \$500–\$50,000 annually (NDA, security, audits, training); protected indefinitely if kept secret (Stiglitz, 2008; Skliaustyte & Weber, 2023).	Continuous protection without public disclosure; suitable for sensitive algorithms/processes; maintains competitive advantage if secret is kept.	Severe restriction of access and scientific verifiability; risk of loss via reverse engineering or disclosure; may hinder scientific collaboration (Skliaustyte & Weber, 2023).
<b>Open Source (public licenses)</b>	Low formal costs (license implementation, community management); variable support/maintenance costs: \$0–\$200,000+ annually depending on the project; immediate publication (Titu & Andronic, 2023; Cole et al., 2023).	Accelerates adoption and collaboration; enables community-driven improvements; alternative business models (services, support, commercial versions).	Maximizes access and interoperability; may reduce incentives for private investment but fosters community innovation (Shavell & Van Ypersele, 2001; Titu & Andronic, 2023).

Source: from (USPTO fees, U.S. Copyright Office fees, United States Patent and Trademark Office, 2023, U.S. Copyright Office, n.d.)

Progress in neurosurgery depends not only on individual or team effort but also on the interdependence between access to technology, clear regulations regarding its licensing, and genuine incentives for innovators (Shavell & Van Ypersele, 2001; Davis, 2004). The ethical balance between safeguarding intellectual property and sharing knowledge is vital to modern medical policy (Stiglitz, 2008; Titu & Andronic, 2023).

Accessibility must be continuously evaluated to prevent creating an artificial technological divide between large urban centres with advanced infrastructure and peripheral regions with limited resources; issues related to the costs of patent licenses compared to regional health budgets are documented and require public policy solutions (Skliastyte & Weber, 2023).

The integration of the latest technological solutions into neurosurgical practice thus becomes a complex exercise where ethical and legal considerations are inseparable from technical and clinical ones; proposals aimed at flexible contractual models — such as temporary use agreements or secure information sharing — can help accelerate the spread of innovations without losing the economic benefits generated by patent protection (United States Patent and Trademark Office, 2021; Calixte et al., 2023).



**Figure 3.** This diagram illustrates how scientific research, technological development, IP protection, regulation, and clinical adoption interconnect to form a dynamic system. Each stage involves specific activities and interventions, which are essential for rapid and safe innovation in neurosurgery. The integrated vision fosters technological progress and ensures that discoveries are available to patients as swiftly and safely as possible.

*Source:* own contribution

## 2. ADVANCED MEDICAL IMAGING IN NEUROSURGERY

### 2.1 Computed tomography (CT)

CT uses X-rays to produce detailed cross-sections of the skull and brain tissues and is quick and valuable in assessing intracranial haemorrhages, fractures, and other neurosurgical emergencies (Cole et al., 2023). Unlike MRI, CT offers superior information on tissue density and bone integrity but has limitations in soft tissue resolution and involves exposure to ionising radiation. Recent

innovations—including dose reduction techniques, advanced reconstructions, and spectral imaging—enhance image quality and clinical utility (Schulz, Waldeck, & Mauer, 2012).



**Figure 4. Spiral computed tomography scanning station**  
*Source:* (Courtesy of County Emergency Hospital Bacău)

## 2.2 Magnetic resonance imaging (MRI)

MRI employs magnetic fields and radio pulses to produce images with high spatial resolution, offering detailed visualisation of white and grey matter, tumours, inflammatory lesions, and vascular malformations (Cole et al., 2023; Schulz et al., 2012). The lack of ionising radiation makes MRI suitable for repeated scans; however, high costs and contraindications related to metallic implants remain significant limitations. Improvements in reconstruction algorithms and post-processing software, sometimes protected by intellectual property, are enhancing the diagnostic potential of MRI (Titu & Andronic, 2023).



**Figure 5. Nuclear magnetic resonance scanning station**  
*Source:* (Courtesy of County Emergency Hospital Bacău)

## 2.3 The Role of Intellectual Property in Imaging Development

IP protection—particularly patents and copyrights related to medical software—has been a key factor in encouraging investment in imaging technologies, enabling companies to recover costs and fund future innovations (Stiglitz, 2008; Shavell & Van Ypersele, 2001). However, disputes over intellectual property rights can impede the clinical implementation of certain technologies, and case law shapes how patents are defined and enforced (Litman, 2018; United States Patent and Trademark Office, 2018).

### **3. INTELLECTUAL PROPERTY: AN INCENTIVE FOR INNOVATION OR A BARRIER TO ACCESS?**

#### **3.1 IP as an incentive for innovation**

A strong IP regime offers financial incentives for companies and academic institutions to invest in developing new medical technologies, since commercial exclusivity enables the recovery of investments and further reinvestment in research (Davis, 2004; Stiglitz, 2008). Examples from biotechnology history emphasise the crucial role of patents in turning discoveries into market-ready products (Shavell & Van Ypersele, 2001).

#### **3.2 IP as a barrier to access**

Excessive or inadequately enforced protection can hinder access to essential technologies, particularly in resource-limited countries; equipment and licensing costs may be prohibitive, and litigation can delay widespread adoption (Skliastyte & Weber, 2023). Empirical studies demonstrate that remuneration policies and subsidies can serve as alternatives or complements to stimulate innovation (Skliastyte & Weber, 2023; Biasi & Moser, 2020).

#### **3.3 Ethical and geopolitical balance**

Finding a balance between safeguarding innovators and ensuring fair access is a significant ethical and geopolitical challenge; decisions regarding the level of protection, compulsory licensing, or public policies can influence global health inequalities (Stiglitz, 2008; Titu & Andronic, 2023).

### **4. STRATEGIES TO PROMOTE INNOVATION AND ACCESS**

#### **4.1 Licensing and Collaborative Agreements**

Licensing remains a crucial mechanism through which companies enable third parties to utilise patented technologies in exchange for royalties, promoting the wider distribution of innovations, particularly in lower-income countries (United States Patent and Trademark Office, 2021). Collaborative agreements between companies, universities, and non-profit organisations continue to foster innovation and enhance access to vital medical technologies. However, other important aspects of accessibility must also be acknowledged (Davis, 2004).

An often-overlooked aspect is how accessible neurosurgeons are to advanced radiological imaging, supported by specialised software. Even if a hospital has cutting-edge CT and MRI equipment, physicians need access to high-performance software for image processing, interpretation, and manipulation. The expense of this software can be prohibitive, restricting physicians' ability to make accurate diagnoses and plan effective treatments (U.S. Copyright Office, n.d.-a). This economic challenge also affects the hospital as a unit. Investing in advanced imaging technologies requires substantial financial resources, and ongoing costs for maintenance, upgrades, and training can be burdensome (United States Patent and Trademark Office, 2023). Who bears these costs, and by what method? Health insurance systems, governments, or patients? The answer varies greatly depending on each country's health system and reimbursement policies (Stiglitz, 2008).

The diversity of hospital units, with different management and resources, further complicates access. With their larger budgets and focus on research, university hospitals may have easier access to advanced technologies than municipal or county hospitals (Cole et al., 2023). This disparity can create inequities in the quality of care received by patients.

Considering these challenges, a unified national strategy must coordinate and standardise access to advanced medical technologies across various healthcare facilities. This strategy should include:

- Government investment in medical imaging infrastructure, prioritising underserved areas (Skliastyte & Weber, 2023).
- Fair reimbursement policies that cover the acquisition, maintenance, and training costs of advanced technologies (United States Patent and Trademark Office, 2023).
- Continuing education programmes for neurosurgeons to ensure they possess the necessary skills to effectively utilise specialised software (Tyskbo & Sergeeva, 2022).
- Standardisation of imaging protocols and data formats to facilitate information exchange between medical facilities (World Intellectual Property Organization, n.d.).
- Collaborative protocols between hospitals, universities, and companies to develop and implement innovative solutions (Titu & Andronic, 2023). By adopting such a strategy, it can be ensured that all patients, regardless of where they live or the hospital they are treated in, have access to the advanced medical imaging technologies they need to benefit from quality medical care (Calixte et al., 2023).

#### **4.2 Government Policies and International Initiatives**

Governments play a vital role in fostering an optimal balance between innovation and access in medical technologies by implementing suitable policies, making strategic investments in research and development, and enforcing existing laws and regulations (Shavell & Van Ypersele, 2001). Grants and funding for both basic and applied research drive the development of new imaging techniques, such as CT and MRI, ensuring a steady stream of innovations (Davis, 2004). Policies that promote fair competition and lower barriers to entry can also enhance access to current technologies, ensuring a broader distribution of benefits (Stiglitz, 2008).

Furthermore, case law is vital in interpreting and applying intellectual property laws, shaping how patents are granted and enforced (Litman, 2018). Court rulings can clarify the scope of patent protections, establish boundaries on anticompetitive practices, and guide licensing and technology transfer (United States Patent and Trademark Office, n.d.). International initiatives, such as those coordinated by the World Health Organization and specialised intellectual property bodies, can support global efforts to improve access to essential health technologies by setting standards, encouraging cross-border cooperation, and offering technical and financial aid to resource-limited countries (World Intellectual Property Organization, n.d.; United States Patent and Trademark Office, 2018).

#### **4.3 Alternative IP Protection Mechanisms**

Along with patents, which are the primary form of intellectual property protection in health technologies, several other mechanisms can encourage innovation without creating significant barriers to access (Titu & Andronic, 2023). Copyright, for example, is a useful tool for safeguarding software used in medical imaging, such as CT and MR image reconstruction algorithms, graphical user interfaces, or data analysis systems (Biasi & Moser, 2020). Unlike patents, which protect an invention's core idea, copyright safeguards its tangible expression; therefore, a competitor can develop similar software if they do not copy the copyrighted source code (U.S. Copyright Office, n.d.-b). Copyrights provide narrower protection than patents, but they can be easier to obtain and help secure investments in software development (United States Patent and Trademark Office, 2018).

On the other hand, trademarks safeguard companies' names and logos, helping to create a strong brand identity and foster consumer trust (United States Patent and Trademark Office, 2021). Trademarks do not protect technologies directly, but they can be used to distinguish products and services from competitors and establish a reputation for quality and innovation. In medical imaging,

trademarks may be used to protect the names of CT and MRI equipment, diagnostic services, or training programmes for medical personnel (United States Patent and Trademark Office, 2021).

Trade secrets are another form of intellectual property protection that can be used to safeguard confidential information, such as chemical formulas, data processing algorithms, or manufacturing processes (Skliastyte & Weber, 2023). Unlike patents, trade secrets are not disclosed to the public, meaning there is no fixed period of protection; however, trade secrets are vulnerable to independent discovery or reverse engineering, which means they are only suitable for information that can be kept confidential (Stiglitz, 2008).

Besides traditional mechanisms, there are newer methods such as open-source licences, which permit the use and modification of software under specific conditions (Titu & Andronic, 2023). Open-source licences can encourage collaboration and innovation in medical imaging, enabling researchers and developers to expand on others' work and enhance existing technologies (Cole et al., 2023). However, open-source licences may also diminish the motivation for companies to invest in creating new software, since they cannot secure exclusive rights for their inventions (Shavell & Van Ypersele, 2001).

The choice of the appropriate mechanism for intellectual property protection depends on several factors, such as the type of information to be protected, the cost involved, and the level of protection desired. Combining different mechanisms can often be the most effective way to safeguard intellectual property and encourage innovation, while ensuring access to vital technologies (Davis, 2004; World Intellectual Property Organization, n.d.).

## **5. ETHICAL AND GEOPOLITICAL IMPLICATIONS OF INTELLECTUAL PROPERTY**

### **5.1 Ethical Dilemmas in Resource Allocation**

The allocation of limited medical resources, including access to advanced imaging, presents normative dilemmas about prioritisation criteria. Clear principles must be established that balance clinical efficiency, equity, and social responsibility in allocation decisions (Stiglitz, 2008). Ethical issues intersect with economic decisions concerning subsidies and incentives for innovation (Skliastyte & Weber, 2023).

### **5.2 IP and Global Inequalities**

IP systems can increase disparities between wealthy and low-income countries, affecting diagnosis, treatment, and long-term outcomes (Titu & Andronic, 2023). Public policy models and international agreements can reduce these effects if they are designed to safeguard public health in the long run (United States Patent and Trademark Office, 2018; World Intellectual Property Organization, n.d.). Empirical studies on how regulations impact scientific dissemination also offer valuable insights into how protective policies affect access to knowledge (Biasi & Moser, 2020; Litman, 2018).

### **5.3 Geopolitical Implications**

Control over essential medical technologies can serve as a factor of geopolitical influence. States and economic actors that possess strategic patents can shape international access to these technologies and utilise intellectual property rights in trade and diplomatic negotiations (Shavell & Van Ypersele, 2001; Stiglitz, 2008). The origins of past disputes over biomedical patents highlight the political and economic significance of these rights (Litman, 2018).

## 6. CONCLUSIONS

Intellectual property protection has been a crucial driver of technological progress in medical imaging, supporting the development of CT and MR and funding the research necessary for major innovations (Schulz, Waldeck, & Mauer, 2012; Cole et al., 2023). However, uncritical or rigid use of IP tools can restrict access to essential technologies and worsen global health disparities (Skliastyte & Weber, 2023; Titu & Andronic, 2023). To maximise medical and societal benefits, a combination of policies is essential: strategic licensing, public-private partnerships, coordinated international efforts, and alternative IP protection mechanisms that balance incentives for innovation with tangible accessibility measures (United States Patent and Trademark Office, 2018; United States Patent and Trademark Office, 2023).

## 7. DISCUSSIONS

Modern neurosurgery is progressing, and imaging techniques are becoming increasingly important in diagnosing and treating complex neurological disorders. Computed tomography (CT) and magnetic resonance imaging (MRI) are vital tools, but access to these technologies varies greatly depending on the resources and infrastructure of each medical centre (Schulz et al., 2012; Cole et al., 2023). This disparity prompts a series of questions and discussion points that deserve further exploration in the future, from technological, ethical, and social perspectives.

An important aspect in the evolution of imaging technology is the impact of intellectual property (IP). Although IP protection encourages innovation and promotes investment in research and development, patenting and licensing technologies can create significant financial obstacles, restricting access for many medical centres, particularly in low- and middle-income countries (Skliastyte & Weber, 2023; Titu & Andronic, 2023). In this context, close collaboration between researchers, manufacturers, and medical institutions becomes crucial for developing more accessible imaging equipment and technologies tailored to the specific needs of different regions (Calixte et al., 2023). Developing portable, affordable equipment could be an innovative approach to reducing access disparities and enhancing patient care in disadvantaged areas (Cole et al., 2023).

Another key aspect of these perspectives involves integrating artificial intelligence (AI) into medical image interpretation. AI has the potential to greatly enhance the accuracy and efficiency of diagnosis, enabling rapid lesion detection and characterisation. However, it also raises fundamental issues regarding data ownership, confidentiality, ethical responsibility, and algorithmic transparency (Tyskbo & Sergeeva, 2022; Titu & Andronic, 2023).

Therefore, developing a clear ethical and legal framework is essential for the responsible use of these technologies, avoiding potential conflicts and safeguarding patient rights. At the same time, we must recognise the critical role of ongoing training for medical personnel in effectively using these systems and accurately interpreting results, which is vital for informed clinical decision-making (Cole et al., 2023; Schulz et al., 2012).

Besides these technological issues, a social and ethical challenge is the shortage of qualified human resources to operate and interpret radiological images. Limited access to modern equipment is not the sole obstacle; investing in education, training, and professional development programmes for medical staff becomes essential if we are to guarantee the optimal use of imaging technologies and avoid incorrect clinical decisions (United States Patent and Trademark Office, 2023; Calixte et al., 2023). Simultaneously, these issues form part of a wider context of global health disparities, where unequal access to technology worsens differences in diagnosis, treatment, and long-term outcomes (Stiglitz, 2008; Skliastyte & Weber, 2023).

A comprehensive strategy to reduce these disparities must involve strategic investments in infrastructure, equitable public reimbursement policies, and standardisation of imaging protocols and data formats. Furthermore, collaboration between hospitals, universities, and the private sector

should be intensified to foster innovation and develop tangible solutions, such as portable and affordable equipment, to enhance healthcare quality in underserved and resource-poor regions (World Intellectual Property Organization, n.d.; United States Patent and Trademark Office, 2018). Effective public and international policies supporting this initiative require mobilising government funds and international organisations to create and distribute accessible technologies, thereby helping to decrease global health inequalities (United States Patent and Trademark Office, 2023; Titu & Andronic, 2023).

It is also essential to focus on the education and training of healthcare professionals, as, beyond technological access, possessing the right skills is crucial for the effective and safe use of advanced imaging. Investments in training programmes, both at the individual and organisational levels, are vital to ensure that physicians and technicians can make well-informed clinical decisions in line with the latest standards (Cole et al., 2023; Schulz et al., 2012). Consequently, strengthening specialised human resources should be a priority both nationally and internationally, in line with technological progress.

Accessible and fair access to modern imaging technologies, coupled with suitable legislation and training, must form the foundation of a global strategy aimed at reducing disparities and maximising the benefits of technology in neurosurgery. Only through this approach can we guarantee quality care for all patients, regardless of available resources, and progress towards a modern, responsible, equitable, and sustainable neurosurgery amidst the rapid development of science and technology (Calixte et al., 2023; World Intellectual Property Organization, n.d.).

## REFERENCES

- Biasi, B. & Moser, P. (2021). Effects of Copyrights on Science: Evidence from the WWII Book Republication Program. *American Economic Journal: Microeconomics* 13(4), 218–60. <https://doi.org/10.1257/mic.20190113>
- Calixte, A., Lartigue, S., McGaugh, S., Mathelier, M., Patel, A., Siyanaki, M. R. H., Pierre, K., & Lucke-Wold, B. (2023). Neurointerventional Radiology: history, present and future. *Journal of Radiology and Oncology*, 7(2), 026–032. <https://doi.org/10.29328/journal.jro.1001049>
- Cole, K. L., Findlay, M. C., Kundu, M., Johansen, C., Rawanduzy, C., & Lucke-Wold, B. (2023). The role of advanced imaging in neurosurgical diagnosis. *Journal of Modern Medical Imaging*, 1. <https://doi.org/10.53964/jmmi.2023002>.
- Davis, L. (2004). Intellectual property rights, strategy and policy. *Economics of Innovation and New Technology*, 13(5), 399–415. <https://doi.org/10.1080/1043859042000188683>
- Litman, J. (2018). What We Don't See When We See Copyright as Property. *The Cambridge Law Journal*, 77(3), 536–558. <https://doi.org/10.1017/S0008197318000600>
- Schulz, C., Waldeck, S., & Mauer, U. M. (2012). Intraoperative image guidance in Neurosurgery: development, current indications, and future trends. *Radiology Research and Practice*, 2012, 1–9. <https://doi.org/10.1155/2012/197364>
- Shavell, S. & Van Ypersele, T. (2001). Rewards versus intellectual property rights. *The Journal of Law and Economics*, 44(2), 525–547. <https://doi.org/10.1086/322811>
- Skliastyte, E., & Weber, M. (2023). Subsidies versus intellectual property rights when innovators operate in two markets. *PLoS ONE*, 18(4), e0284880. <https://doi.org/10.1371/journal.pone.0284880>
- Stiglitz, J. E. (2008). Economic foundations of intellectual property rights. *Columbia Academic Commons (Columbia University)*, 57(6), 1693–1724. <https://doi.org/10.7916/d8474m9p>

- Titu, A. M. & Andronic, D. (2023). Intellectual property applied to medical imaging systems in present context. *Annals of the Academy of Romanian Scientists Series on Economy, Law and Sociology*. 6. 22-40. <https://doi.org/10.56082/annalsarscieco.2023.2.22>
- Tyskbo, D. & Sergeeva, A. (2022). Brains exposed: How new imaging technology reconfigures expertise coordination in neurosurgery, *Social Science & Medicine*, 292, 114618, <https://doi.org/10.1016/j.socscimed.2021.114618>
- U.S. Copyright Office. (n.d.) *How long does copyright protection last? (FAQ)*. Retrieved from <https://www.copyright.gov/help/faq/faq-duration.html>
- U.S. Copyright Office. Fees. (n.d.) Available at <https://www.copyright.gov/about/fees.html>
- United States Patent and Trademark Office. (2024) *Copyright basics*. Retrieved from <https://www.uspto.gov/ip-policy/copyright-policy/copyright-basics>
- United States Patent and Trademark Office. (2021) *Trademark basics*. Retrieved from <https://www.uspto.gov/trademarks/basics>
- United States Patent and Trademark Office. (2023). *Pendency patents dashboard*. Retrieved from <https://www.uspto.gov/dashboard/patents/pendency.html>
- United States Patent and Trademark Office. (2023). *USPTO fee schedule*. Retrieved from <https://www.uspto.gov/learning-and-resources/fees-and-payment/uspto-fee-schedule>
- United States Patent and Trademark Office. (n.d.) *IP basic toolkits*. Retrieved from <https://www.uspto.gov/learning-and-resources/inventors-and-entrepreneurs/ip-basic-toolkits>
- World Intellectual Property Organization. (n.d.) *International Patent Classification (IPC)*. Retrieved from <https://www.wipo.int/classifications/ipc/en/index.html>