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Basic science in neurosurgery

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Over the years, basic research and neurosurgery have been closely intertwined, attempting to rapidly translate discoveries in the lab into benefit for our patients, and using clinical experience to steer our scientific endeavors. However, recent data shows that the participation and interest in basic science of neurosurgeons and residents is waning, with NIH funding to surgical departments in general steadily declining over the past decades (Hu et al., 2015). Various reasons, such as the pressure to be clinically productive, excessive administrative duties, difficulty in obtaining funding or simply a desire for an improved work-life balance, are decreasing the time spend on science (Keswani et al., 2017). In this editorial we would like to advocate for a renewed interest and commitment to basic science by neurosurgeons, neurosurgical residents, and neurosurgical departments.

The main goal of any physician is to improve the health and life of its patients. While neurosurgical procedures have been greatly refined over the decades and the outcomes of our surgeries have improved, the outcomes of many of the diseases we treat have not. Patients with glioblastoma, and traumatic brain or spinal injuries have only seen marginal improvement over the last decades. Focusing solely on optimizing our current approaches to these disease may only deliver limited improvements. To paraphrase a quote often attributed to the American entrepreneur Henry Ford: "If we had asked people what they wanted, they would have said faster horses." To truly propel our field forward and improve the life of our patients, we must look to basic science. As neurosurgeons and neurosurgical trainees, we are uniquely situated between patient, disease, anatomy, and pathophysiology, and can therefore be the link between the lab and the clinic. From the practical to the experimental, every doctor practicing neurosurgery has ideas to improve patient care, but many lack the scientific tools and resources to bring these ideas to fruition. Biomedical scientists have these tools at their disposal, but are not always able to accurately identify the current clinical challenges or knowledge-gaps. Neurosurgeons and neurosurgical trainees can help closing these gaps by improving their knowledge and increasing their participation in basic science, helping steer the scientific resources and attention to solving relevant clinical problems for our patients. Furthermore, intimate knowledge of science and the scientific method also helps to grasp the potential and limitations of new therapies and current clinical trials. Not only does this help in finding the right trial or treatment for the patient and thus improving patient access to it, it also allows us to better inform our patients on the possibilities and limitations of these novel therapies.

Aside from improving patient care, a training in basic science can play a beneficial role to the development of medical students and neurosurgical residents. Experience in basic science fosters critical thinking, of the subject matter but also oneself, demanding critical appraisal of previously performed work. While collaboration in the clinic and OR tend to favor a hierarchical approach, experience in basic science can help develop a more egalitarian culture where ideas and strategies are discussed more openly and critically. To effectively discuss complicated cases, excellent verbal and written communication is required, something thoroughly trained in the field of basic science. Creativity and an out-of-the-box-mentality are prerequisites for a good scientist, but also great qualities for any neurosurgeon (in-training) as they deal with intraoperative surprises and clinical challenges. As with neurosurgery, a scientist cannot solely rely on previously thought-out plans and protocols and must learn to improvise in the moment. Finally, and potentially above all, experience in the ups and downs of basic scientific research fosters resiliency in the face of failure, a vital skill in neurosurgery.

So how do we improve our participation in basic science? Does *every* neurosurgeon *need* to devote a significant amount of time to it? To start, we feel that every residency program should include a year solely dedicated to science, ideally towards the end of residency. The resident can thus already apply some of their clinical experience to a scientific project, and propagating these projects after residency is finished may be more practical when started in the later years. Alternatively, early participation in science during residency may help steer the resident's interests in the clinic and could be less disruptive in the transition from senior resident to junior neurosurgeon towards the end of training. Independence and creativity in choosing a scientific project, closely related to neurosurgery or not at all, and choice in timing of this project in residency is essential, and fosters a diverse scientific background for the residents as a group and neurosurgery as a whole. Time spend on science during residency does mean less time spend on other aspects of neurosurgical training and sacrificing at least some hands-on neurosurgical experience in the operating theatre. While technical dexterity is obviously essential, residency is just the start of the development of these skills which are continuously

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improved during a life-time of surgery. Alternatively, an extension of the residency could be offered to allow for research experience without sacrificing surgical time, but this has its own drawbacks. Overall, believe that neurosurgical residency should encompass the development of neurosurgeons in the broadest possible sense and should expand to science, but also leadership, communicative skills, and an entrepreneurial spirit. A scientific internship can foster these skills and help prepare residents for a career in the dynamic field of neurosurgery.

Once fully fledged neurosurgeons, it is critical that departments allow neurosurgeons to dedicate time to science. In the short term, this may mean sacrificing (more billable) time spend elsewhere, but over time, collaboration between (non-neurosurgical) departments, acquisition of research grants, and improved partnerships with industry, may actually increase available funds to the department. Attempts to quantify or qualify scientific output are challenging, and efforts to maximize output and citations have not led to more creative or revolutionizing work (Park et al., 2023). Instead, we should emphasize involvement in science by ourselves and colleagues in the broadest sense of the word, allowing for project that may seem far-fetched and are only expected to bear fruits in many years' time.

In the end, we do not advocate for mandatory basic research participation for every neurosurgeon. Dedicated research time during neurosurgical training can however improve resident development in many ways. As neurosurgical trainees and neurosurgeons, we have an obligation to work on not just delivering excellent care every day, but also continuously improving the care we deliver our (future) patients. Scientific research is a fundamental part of this. From the lab to the clinic, from private conversations to the public discord, and from university to industry, we should aim to be involved in improving the care we deliver every step of the way. Basic research can serve as a foundation from which to launch our creativity and provide the tools to develop a better future in neurosurgery.

Declaration of interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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