Excellence in Neurosurgery Program Building: Enhancing the Academic Mission

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Having talked about excellence in research in neurosurgical oncology and clinical neurosurgery, I will use this opportunity to speak about excellence in neurosurgery program building and enhancing the academic neurosurgery mission. It has been my great honor to serve as chairman of the Division of Neurosurgery at the University of Toronto these past 10 years. I have had the distinct pleasure of serving with many talented faculty and neurosurgery residents. As a result, it has been relatively straightforward to build programs around these individuals who have been instrumental in the initiatives that have come forward in our division.

FROM THE BEGINNING: EXCELLENCE IN LEADERSHIP

In Toronto, we lay claim to a neurosurgical heritage that can be traced back to Dr Harvey Cushing. Neurosurgery in Canada was first officially recognized as a subspecialty in surgery in 1923, when the University of Toronto and the Toronto General Hospital sponsored Kenneth George McKenzie to train under Dr Cushing when he was in Boston at the Brigham Hospital. Dr Cushing had been awarded a generous fellowship for his pioneering work in neurosurgery by Dr William Mickle, a University of Toronto–trained physician who went to London, England, to practice medicine. Dr Cushing asked Dr C.L. Starr, professor of surgery in Toronto at that time, to direct the fellowship toward a Canadian trainee who would come to Boston to train with him. Dr McKenzie was the fortunate recipient of the scholarship and trained as a house officer for 1 year with Dr Cushing. As can be imagined, Dr. Cushing was a tough taskmaster, but Dr McKenzie learned the fundamentals of operative neurosurgery from Dr Cushing (Figure 1).

On Dr McKenzie's return to Toronto in 1924, he limited his practice to operations on the nervous system. The University of Toronto Division of Neurosurgery thus became the first neurosurgical program in Canada. McKenzie was a brilliant technical neurosurgeon who made significant contributions to operative procedures for acoustic neuroma, spasmodic torticollis, glioblastoma multiforme, and chronic pain.[1-4] McKenzie served as president of the Harvey Cushing Society from 1936 to 1937. He was president of the Society of Neurological Surgeons from 1948 to 1949. He was a founding member of the editorial board of the *Journal of Neurosurgery* and served as its editor from 1943 to 1950. The Canadian Neurosurgical Society honored Dr McKenzie with the creation of the annual McKenzie Prize in 1973, awarded to the neurosurgery resident who presents the best scientific paper at the annual Canadian Congress of Neurological Sciences meeting.

Over the years and in the generations that followed McKenzie, excellence in neurosurgery leadership in Toronto was maintained. Dr E.H. Botterell became the next chair of neurosurgery after Dr McKenzie from 1952 to 1962 (Figure 2). Dr Botterell was a master organizer and superb administrator. He is best known for his efforts on the grading of aneurysmal subarachnoid hemorrhage and for organizing the first rehabilitation center for spinal cord–injured patients.[5-10] In 1962, Dr T.P. Morley became chair of neurosurgery for a period of 17 years (Figure 3). Dr Morley had trained in neurosurgery under Sir Geoffrey Jefferson in Manchester, England. Dr Morley's major contributions included the establishment of a neuro-oncology research laboratory, the development of the formal neurosurgery training program at the University of Toronto, and his expertise in complex neurosurgical operative cases including skull base meningiomas, acoustic neuromas, and cavernous sinus surgery.[11,12] In 1979, Dr Alan Hudson assumed the chair in Toronto (Figure 4). His main clinical efforts were focused on peripheral nerve surgery, and in this field, he worked closely with his friend and colleague, Dr David Kline, to write the seminal works in this field at that time.[13-23] Having trained in the United Kingdom in general surgery, Dr Hudson was a consummate surgical neuroanatomist. He promoted the surgeon-scientist model at the University of Toronto and encouraged numerous residents to pursue their research interests in the laboratory. The next chairman was Dr Charles Tator, who was chairman from 1989 to 1999 (Figure 5). His main research interest was in the area of spinal cord injury,[24-41] and he was an accomplished spinal neurosurgeon. Dr Tator was also strongly supportive of the

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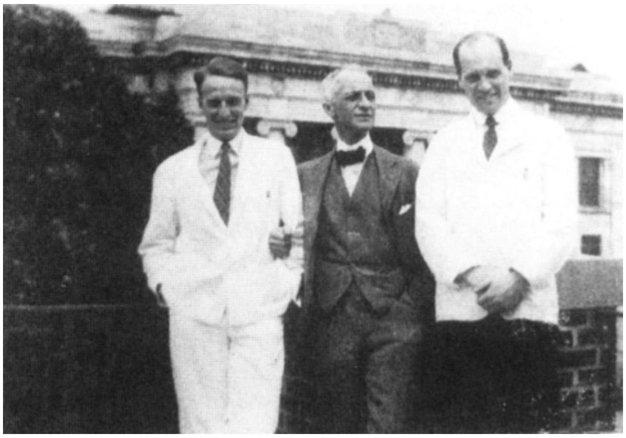

FIGURE 1. Drs K.G. McKenzie (left), Harvey Cushing (center), and James Paterson Ross (right) in 1922 at the Brigham Hospital in Boston. Dr McKenzie, Canada's first neurosurgeon, trained for 1 year under Dr Cushing.

surgeon-scientist model, and virtually all residents under his tutelage spent a minimum of 2 years in full-time research, often working toward a higher postgraduate degree at the University of Toronto. With a neurosurgery lineage that is traced to Harvey Cushing, and with a succession of strong leaders as chairs of neurosurgery at the University of Toronto since 1923, it is perhaps not surprising that excellence in neurosurgery program building has been sustained over the past 85 years.

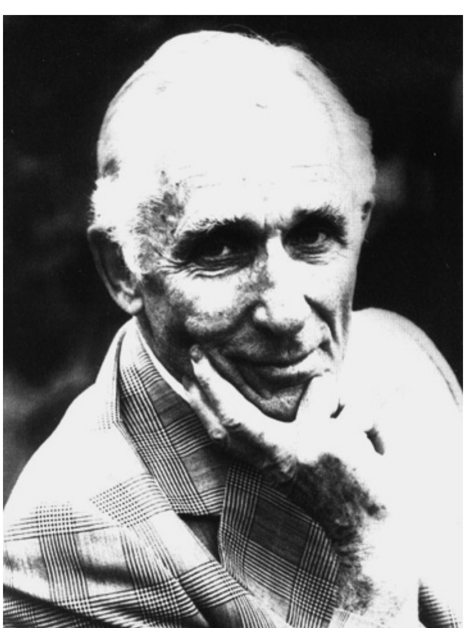

FIGURE 2. Dr E. Harry Botterell, chair of neurosurgery in Toronto after Dr McKenzie, 1952 to 1962.

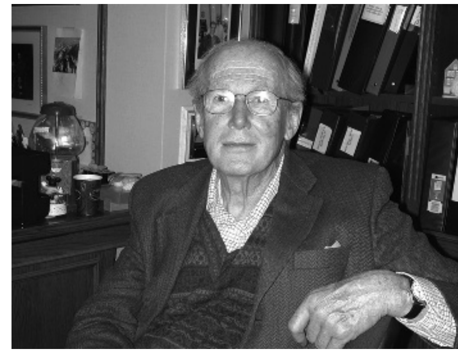

FIGURE 3. Dr T.P. Morley, chair of neurosurgery in Toronto from 1962 to 1979.

NEUROSURGERY AT THE UNIVERSITY OF TORONTO: A CAPTIVE PATIENT POPULATION

There are 4 neurosurgery teaching hospitals within the University of Toronto: St Michael's Hospital, Sunnybrook Hospital, Toronto Western Hospital, and the Hospital for Sick Children. Currently, there are 35 residents in the neurosurgery training program and 27 full-time faculty. Each year, approximately 7500 operative cases are performed. Four postgraduate year 1 residents in neurosurgery are accepted each year. The residents rotate to each of these hospitals for 6-month rotations. For a population base in the greater metropolitan Toronto area that numbers >5 million people,

FIGURE 4. Dr A.R. Hudson, chair of neurosurgery from 1979 to 1989. His subspecialty area of interest was peripheral nerve surgery, in which he became a world authority.

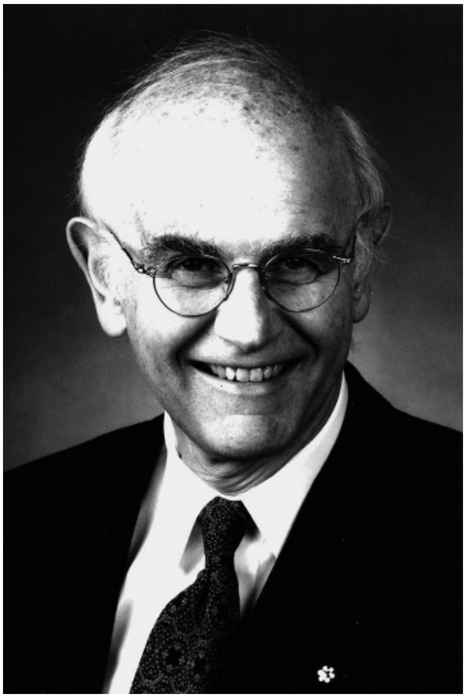

FIGURE 5. Dr C.H. Tator, chair of neurosurgery from 1989 to 1999. Dr Tator's main clinical and research area of interest was spinal cord injury.

there is no other university program nearby and only 1 group of community practice neurosurgeons about 30 miles to the west of Toronto. Thus, the University of Toronto neurosurgery program has a captive patient population and receives numerous referrals from across the province and from other regions of the country, making the clinical practice of neurosurgery richly diverse and bountiful. At the postgraduate year 4 level, most neurosurgery residents enter the formal Surgeon:Scientist Program and spend a minimum of 2 years in the laboratory pursuing a research project of interest. At this juncture, I should like to focus on one of the neurosurgery teaching hospitals in Toronto, the Hospital for Sick Children, as an example of a unit that has demonstrated sustained excellence over numerous decades.

THE HOSPITAL FOR SICK CHILDREN: A TRADITION OF EXCELLENCE

None of us is as smart as all of us.
— Ken Blanchard

Dr William Keith was the first neurosurgeon to practice at the Hospital for Sick Children (Figure 6). Having trained in Chicago under Drs Percival Bailey and Paul Bucy and in London at Queen's Square in the early 1930s, Dr Keith started to perform surgeries on children with neurosurgical disease in 1933 in Toronto. Dr Keith was one of the first advocates of lumboperitoneal shunting for hydrocephalus in children. During his first 10 years in practice, he developed considerable experience treating children with brain tumors, spina bifida, hydrocephalus, and craniofacial disorders (Figure 7). Through his connections with American neurosurgeons, Dr Keith became one of the founding members of the American

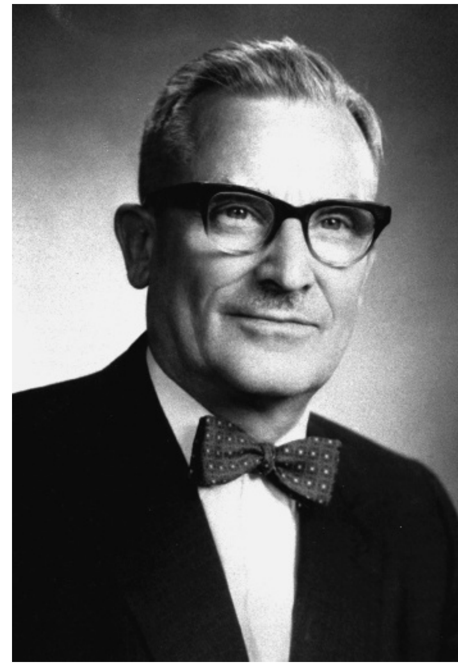

FIGURE 6. Dr William Keith, the first neurosurgeon to practice neurosurgery at the Hospital for Sick Children.

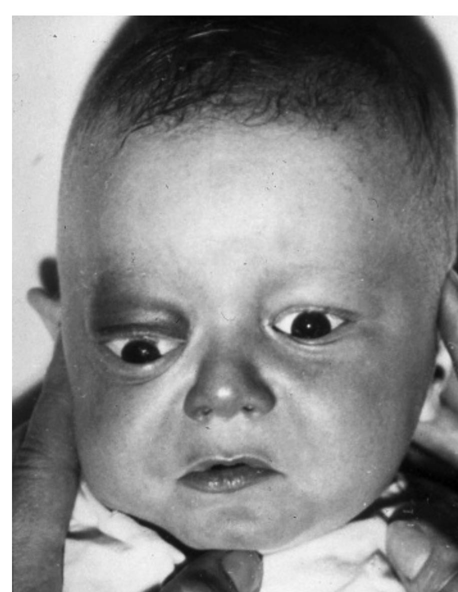

FIGURE 7. Photograph from the slide collection of Dr Keith showing an infant with right proptosis from an optic nerve glioma.

Academy of Neurological Surgery. One of his closest friends professionally was Dr Frank Mayfield from Cincinnati. Dr Keith also started the neurosurgery service at the Toronto Western Hospital, where he performed numerous cases in adult neurosurgery. The William Keith Lectureship was established in his name at the Toronto Western Hospital in 1976.

The first fully trained pediatric neurosurgeon in Canada was Dr Bruce Hendrick, who trained under Drs Donald Matson and Franc Ingraham at the Brigham and Women's and Children's Hospital in Boston in 1952. Dr Hendrick began his practice as a full-time pediatric neurosurgeon at the Hospital for Sick Children in 1954. For the next 10 years, he was the sole pediatric neurosurgeon for the city of Toronto and for a geographic region far beyond. In 1964, he was joined by Dr Harold Hoffman, who had trained in neurosurgery in Toronto but spent 1 year in Europe on a McLaughlin Surgical Fellowship. In 1972, Dr Robin Humphreys, another Toronto trainee, joined forces with Drs Hendrick and Hoffman, and with this, the era of the ''3H's'' began (Figure 8). It is difficult to describe in words the impact that these 3 neurosurgeons had on the specialty of pediatric neurosurgery. They were instrumental in shaping the future of pediatric neurosurgery as a subspecialty. Together, they wrote many of the early seminal treatises on hydrocephalus, epilepsy, cerebrovascular disease, congenital spinal disorders, central nervous system infection, and head injury, to name just a few.[42-68] The 3H's were founding members of the American Society of Pediatric Neurosurgery. From 1972 to 1990, they trained numerous fellows in pediatric neurosurgery who came to Toronto from all over the globe to learn the nuances of this subspecialty area of neurosurgery.

Let us focus for a moment on the contributions of Dr Hoffman. He was neurosurgeon-in-chief at the Hospital for Sick Children from 1986 to 1996; he also was president of the American Society of Pediatric Neurosurgeons, the International Society for Pediatric Neurosurgery, and the Canadian Congress of Neurological Surgeons. He had > 200 peer-reviewed publications. A gifted technical neurosurgeon and a voluminous writer, Dr Hoffman recognized from an early stage that pediatric nervous system disease was different from and yet complementary to adult disease, and he catalogued his observations through his publications and slide collection, which grew to considerable proportions over his career. For those interested readers, the H.J. Hoffman slide collection can be found, in part, at the University of Toronto Division of Neurosurgery Web site (http://www.surg.med.utoronto.ca/neuro/slides.html). Dr Hoffman is perhaps best remembered for his stand on the radical resection of craniopharyngiomas, about he which he wrote and spoke on numerous occasions.[52,69] In his name, the Hoffman Chair in Pediatric Neurosurgery was established at the Hospital for Sick Children. One of the defining cases in Dr Hoffman's career was the separation of the Jamal craniopagus twins from Pakistan (Figure 9). These twins, joined at the vertex, shared a common superior sagittal sinus. After an intense 18-hour operation, Dr Hoffman successfully separated the twins, who survived the procedure; one twin has survived long term totally intact from a neurological perspective.[70]

The next generation of pediatric neurosurgery at the Hospital for Sick Children began with the recruitment of future neurosurgeon-scientists. Dr James Drake, a Princeton undergraduate and aerospace engineer, was recruited to investigate the role of robotics in the removal of complex and deep intracranial tumors (Figure 10).[71] With his background in engineering, Dr Drake has patented a novel shunt valve for hydrocephalus and has been an innovator in surgical neuronavigation.[72] Recently, he has focused on clinical trial design especially as it applies to hydrocephalus, shunt placement, and valve selection.[73-78] In addition, he has developed a large experience with endoscopic approaches to the ventricular system to treat children with noncommunicating hydrocephalus.[79] Dr Drake is currently the neurosurgeon-in-chief at the Hospital for Sick Children.

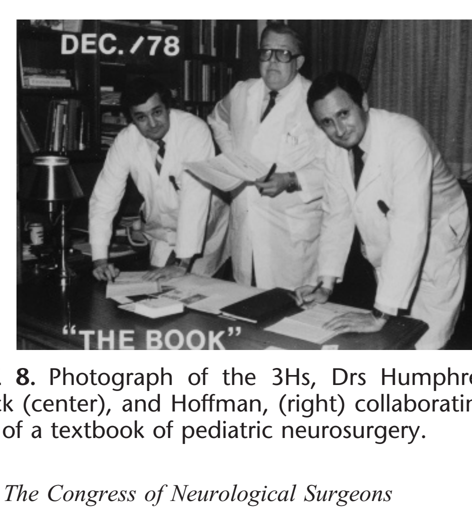

FIGURE 8. Photograph of the 3Hs, Drs Humphreys (left), Hendrick (center), and Hoffman, (right) collaborating on the writing of a textbook of pediatric neurosurgery.

FIGURE 9. Preoperative photograph of the Jamal craniopagus twins in Toronto before separation. They were a vertex craniopagus and shared a common sagittal sinus.

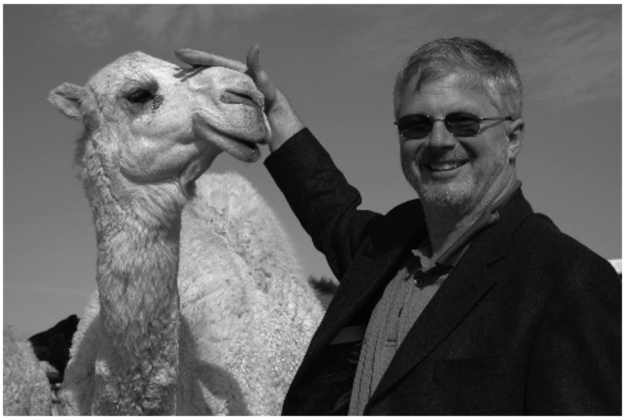

FIGURE 10. Dr J.M. Drake, neurosurgeon-in-chief at the Hospital for Sick Children. A graduate of Princeton University in aerospace engineering, Dr Drake has pioneered the use of robotics in neurosurgery and novel shunt valve design.

Dr Peter Dirks was recruited to the neurosurgical staff at the Hospital for Sick Children because of his specialized interest in the molecular biology of pediatric brain tumors with a focus on cancer stem cells.[80-83] He was recently named one of Canada's ''Top 40 Under 40'' (http://www.top40award-canada.org/) (Figure 11). His publications are found in high-impact basic science journals, and he is considered a world leader in brain tumor stem cells.[84-88] His main clinical area of interest is vascular neurosurgery in children with a focus on arteriovenous malformations and moyamoya disease.

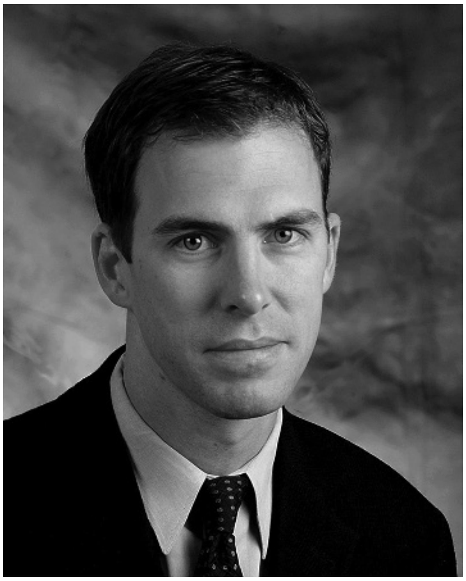

FIGURE 11. Dr P.B. Dirks, one of Canada's Top 40 Under 40 and the first researcher to describe the importance of stem cells in pediatric brain tumors.

Dr Abhaya Kulkarni was recruited to the Division of Neurosurgery at the Hospital for Sick Children after Dr Dirks. Dr Kulkarni received his PhD in clinical epidemiology from McMaster University (Figure 12). He is an leading authority on clinical trial design in pediatric neurosurgery and has recent publications in the *Journal of the American Medical Association*, *Journal of Pediatrics,* and *Journal of Neurosurgery*.[89-94] He has specialized clinically in craniofacial surgery. Finally, Dr Michael Taylor has been recruited to the Division of Pediatric Neurosurgery for his novel research work on the genomics of pediatric brain tumors (Figure 13). He too is a recipient of one of Canada's Top 40 Under 40 awards. His work has been published in *Nature Genetics*, *Cancer Research*, *Oncogene,* and *Cancer Cell,* among many other high-impact scientific journals.[95-103]

The recruitment of talented young faculty to any Department of Neurosurgery is one of the prime methods of rejuvenating and building an academic program. The Division of Neurosurgery at the Hospital for Sick Children continues to attract the best and brightest pediatric neurosurgery fellows from around the globe. Each year, visiting dignitaries in pediatric neurosurgery from other centers are invited to deliver special lectures such as the E. Bruce Hendrick Lectureship in Pediatric Neurosurgery. The reader interested in the history of pediatric neurosurgery at the Hospital for Sick Children is referred to the review by Jea et al.[104]

EXCELLENCE IN PEDIATRIC NEURO-ONCOLOGY CARE

Few of us can do big things; but we can do small things in a big way.

— Mother Teresa

Pediatric brain tumors are the most common form of cancer in the pediatric population after leukemia. Tumors in children have a propensity to occur in the sellar region, ventricles, brainstem, cerebellum, thalamus, and temporal lobe with significant frequency. If one scans a group of young

FIGURE 12. Dr A.V. Kulkarni, staff neurosurgeon at the Hospital for Sick Children with a PhD in clinical epidemiology.

FIGURE 13. Dr M.D. Taylor, one of Canada's Top 40 Under 40, and the discoverer of the suppressor of fused gene mutations in medulloblastoma.

children who are survivors of brain tumors and their treatments (Figure 14), it is often difficult to distinguish those who have had brain tumors from those in the general population because our treatments have become extremely effective these days in returning these children back to normal lives.

Many years ago, a group of parents at the Hospital for Sick Children whose children were being treated for brain tumors came to me and asked me what they could do to help in the fight against pediatric brain cancer. The result was the formation of a group called B.R.A.I.N.child (Brainchild), which stands for the Brain Tumor Research and Information Network. Brainchild is a group of parents, family, and friends who have shared a common experience of caring for a child with a brain tumor. This volunteer organization provides support, education, and research funding to the Hospital for Sick Children. Over the years, numerous fundraising events have taken place, including Rigatoni for Research, Amy's Shining Star, Skating with Daniel, Walking With Grace, Laughing With Ladybugs, Summerfest, and Blading for Brainchild (Figure 15). Since its inception in 1993, Brainchild has raised more than $3 million for brain tumor research. This type of support has been critical for providing seed funding for research proposals that ultimately have received full peer-reviewed funding from national agencies.

BUILDING A CENTER OF EXCELLENCE FOR BRAIN TUMOR RESEARCH

Philanthropy is almost the only virtue which is sufficiently appreciated by mankind.

—Henry David Thoreau

In the 1990s, it became quite clear to my colleagues and me in Toronto that there was a tremendous opportunity for us to take advantage of the relatively large burden of patients with primary brain tumors by forming a center that could study the large number of patient samples in a coordinated fashion. Several of our faculty members had received postdoctoral fellowship training in brain tumor research elsewhere. However, in Toronto, their individual laboratories were housed in different institutions. Accordingly, we built the case for bringing us all together under one roof to form a brain tumor research center (BTRC) and made this proposal part of a multi-institutional capital campaign. Besides myself, the

FIGURE 14. A group of pediatric brain tumor survivors. From this photograph, it is difficult to imagine that these children have been through surgery and adjuvant therapies for such tumors as choroid plexus carcinoma, anaplastic astrocytoma, craniopharyngioma, and medulloblastoma.

FIGURE 15. Blading for Brainchild event organized by the BUNZL Canada group, June 2008. The rollerbladers travelled 60 km in 1 day to raise funds for and awareness of brain tumors in children.

neurosurgeons who were instrumental in working toward this goal were Drs Ab Guha, Mark Bernstein, Harold Hoffman, and Charles Tator.

We were indeed fortunate when, in 1997, Arthur and Sonia Labatt gave so generously to enable us to establish the first BTRC of its kind in Canada (Figure 16). At that time, after their historic \$5 million donation, we held a gala opening of the Labatt BTRC at the Hospital for Sick Children that numerous local and national dignitaries were invited to attend. They included the Governor General of Canada at that time, the Honorable Romeo LeBlanc. This philanthropic gift from the Labatt family was the catalyst we needed to secure space within the Research Institute of the Hospital for Sick Children and to hire basic scientists to help us investigate the basic biology of primary brain tumors. In 1999, there were 4 principal investigators and 20 researchers working toward a common cause. A decade later, the Labatt BTRC had grown substantially to include 10 principal investigators, all with their own peer-reviewed grants and funding base, and $>$ 75 researchers, making it one of the largest BTRCs in the world. As is often the case with grateful donors, 10 years after their initial gift of \$5 million, the Labatt family gave an additional \$5 million to the Labatt BTRC to further support our mission and our goals. This recent donation has enabled us to move to new research space and to grow our research program even further. The Labatt BTRC is now a center with $>$ 15 000 sq ft of space in an open concept design. Each year, an annual academic lectureship is held during which we invite a distinguished scientist to Toronto to speak on their latest findings in the lab. In recent years, these luminaries having included Drs Robert Martuza, Darell Bigner, Henry Brem, Joe Costello, Charles Stiles, and Eric Holland.

FIGURE 16. Arthur and Sonia Labatt shortly after their historic \$5 million donation to the Hospital for Sick Children in 1997 to establish Canada's first Brain Tumor Research Center. Arthur Labatt founded the Trimark Investment Management Company, which became one of Canada's most successful investment firms in history.

What does it take to build a research center of excellence? First, there must be a critical mass of like-minded individuals. These individuals should be well grounded in the realm of hypothesis generation and testing. Each principal investigator should hold a combination of peer-reviewed and private research funding. There should be ample space in which to conduct the research of the program. The institution in which the research is being conducted should help to provide infrastructure to support the scientists within the center. Finally, it is advantageous if the institution has designated the research area as a priority program and part of its strategic goals. All of these features have certainly been a part of the establishment of the Labatt BTRC and have equated to the early success of the center.

BUILDING A PROGRAM OF EXCELLENCE IN CLINICAL NEUROSURGERY

At the University of Toronto, we have indeed been fortunate to have established several endowed chairs in neurosurgery that provide discretionary funds for each of the chair holders. Each chair represents a \$2 million endowment and supports the academic mission of the Division. These chairs include the Keenan Chair in Neurosurgery at St Michael's Hospital held by Dr Loch Macdonald; the Alma Baxter et Ricard Chair in Cerebrovascular Neurosurgery held by Dr Chris Wallace; the Harold J. Hoffman Chair in Pediatric Neurosurgery held by Dr James Drake at the Hospital for Sick Children; the Alan and Susan Hudson Chair in Neurooncology held by Dr Ab Guha; the Ron Tasker Chair in Stereotactic and Functional Neurosurgery held by Dr Andres Lozano at the Toronto Western Hospital; the Krembil Chair in Neuroscience held by Dr Michael Fehlings at the Toronto Western Hospital; the Campeau Chair in Spinal Cord Injury Research held by Dr Charles Tator at the Toronto Western Hospital; and the Dan Family Chair in Neurosurgery, which I hold at the University of Toronto. These endowed chairs can prove to be extremely important in recruiting new faculty to neurosurgery programs or in retaining faculty who may be considering job opportunities at other institutions.

When I became chair of neurosurgery in 1999, the digital age of communication was already quite advanced, so I took the opportunity to establish a Web site for our division (www.surg.med.utoronto.ca/neuro) that houses our history, our clinical and research programs, our curriculum, and our annual academic events, among many other items. Just as it is important to establish a neurosurgery Web site for the world to see, so it is important to maintain the site, and this must be done frequently and creatively. To help further communication among faculty and residents in our program, given that we were separated from each other in 4 different institutions, I created a monthly electronic newsletter, the *Neurosurge*, that delivered updates on upcoming events, recent awards and publications, and a monthly neuroanatomy quiz for neurosurgery residents. In addition, *Neurosurge* provided a unique Web site relevant to neurosurgery each month; a PDF of the month, which was usually a major publication by one of our faculty or residents; and a video of the month (usually from You-Tube, http://www.youtube.com/) that illustrates a neurosurgical procedure of interest. A few years ago, we provided our residents with a Palm Pilot Treo so that they could communicate with faculty electronically, capture their operative data conveniently, and do Internet searches while on rounds or in the hospital as needed.

What does it take to run a successful neurosurgery curriculum? Some of the component parts include dedicated time for teaching; a structured program of lecture topics; organization whereby both faculty and residents are engaged in the teaching and learning process; appropriate and up-to-date content of materials; a method for the examination of residents on the course content material; and a process whereby the entire curriculum can be evaluated and renewed every few years. In our program, we have established blocks of lectures in our curriculum in which topics such as spine, pediatrics, tumors, vascular, and functional neurosurgery, are covered extensively over a 6-month period. At the conclusion of the block of lectures, the residents sit for a written examination, which is created in part by them and by the faculty and is in the format of the Royal College of Surgeons examination. Accordingly, the cognitive performance of our residents can be monitored closely throughout their residency, and those in need of assistance or mentoring can be identified at an early stage. All the lectures in the curriculum are maintained on a password-protected Web site and form a template for study notes as our residents prepare for their final examinations at the Royal College.

For the past several years, we have also enabled our residents to practice neurosurgery in the noncritical environment of the Surgical Skills Centre at the University of Toronto, where they have opportunities to have ''hands-on'' experience in neuroendoscopy, epilepsy neurosurgery, microvascular neurosurgery, spine surgery, and peripheral nerve neurosurgery (Figure 17).

FIGURE 17. Deliberate practice in a noncritical environment. Dr Rutka is demonstrating to neurosurgery residents the nuances of temporal lobectomy for epilepsy in this cadaver course at the University of Toronto Surgical Skills Center, Mount Sinai Hospital.

Throughout the year, we hold several competitions in which our residents participate for their clinical and research projects. These include the Morley Prize for basic science research, the Horsey Prize for clinical research, the Hudson teaching prize, and the Warren Ho Memorial Scholarship award. We also hold several named lectureships, including the William Keith, E.H. Botterell, E. Bruce Hendrick, and Bryan Marshall lectureships, during which keynote lecturers from around the continent are invited to present their latest clinical or research work. These named lectureships provide an excellent opportunity for our faculty and residents to meet outside the workplace in a relaxed social environment to meet with and talk directly to the visiting professors.

An important part of program building is branding. Branding the name and reputation of a department can take several forms. Several years ago, I developed an interest in creating a logo for our program in neurosurgery. With the aid of medical artists Mark Schornak, from the Barrow Neurological Institute, and Ian Suk, from Johns Hopkins University, we fashioned a logo that expressed in art form what neurosurgery in Toronto stood for (Figure 18). With this new logo, I wanted to convey the themes of neurosurgery, neuroscience, and basic science. The logo depicts the human brain

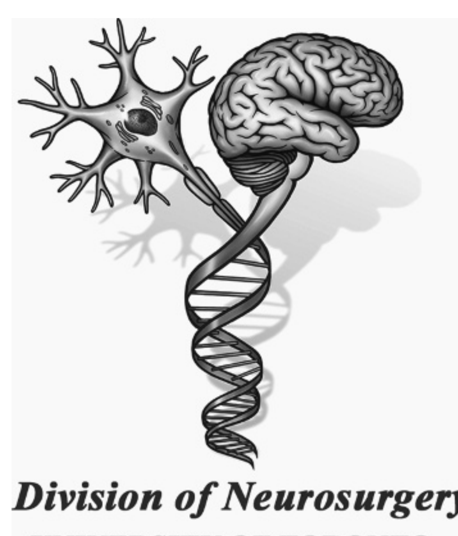

FIGURE 18. The logo of the Division of Neurosurgery at the University of Toronto.

(representing neurosurgery) next to a neuron (representing neuroscience) that spring forth from the unraveling of a double-stranded DNA coil (representing basic science). The current logo adorns our letterhead, Powerpoint presentations, ties, scrub caps, golf shirts, and hockey jerseys.

Currently, at the University of Toronto, there are 34 neurosurgery residents with a preponderance at the postgraduate year 4 level. This is because our postgraduate year 4 residents are frequently in the lab on their research rotations and can be away from clinical service from 2 to 4 years. While in the laboratory, our residents are provided with a postgraduate year 4-level salary, they are mentored by a neurosurgeon in whose lab they are typically conducting their research, they have minimal clinical responsibilities (2-4 call nights per month), and they are often working toward a higher academic degree such as a Master's degree or PhD at the University of Toronto. Some examples of the excellence in resident research performed at the University of Toronto include Dr Sheila Singh's research on brain tumor stem cells performed in the laboratory of Dr Dirks,[83] Dr Gelareh Zadeh's research on angiogenesis in human glioblastoma performed in the laboratory of Dr Guha,[105] and Dr Paul Kongkham's research performed in my laboratory on the identification of a novel tumor suppressor gene called *SPINT2* in human medulloblastoma.[106]

FIGURE 19. Annual chairman's canoe trip, Lake Temagami region, Kokoko Lake, September 2009. Back row, from left to right: Eric Massicotte, Chris Wallace, Chris Getch (Northwestern University), D.J. Cook, James Rutka, Demitre Serletis, and David Cadotte. Front row, from left to right: Jamie Purzner, Erin Kiehna (University of Virginia), Sandi Amaral, Carlo Santaguida, Adrienne Weeks, Adrian Laxton, Teresa Purzner, Kathryn Howe, and Scellig Stone.

BUILDING AN *ESPRIT DE CORPS* IN NEUROSURGERY

Individually, we are one drop. Together, we are an ocean.

— *Ryanosuke Satoro*

Just as it is important for faculty and residents to achieve excellence in clinical neurosurgery and research, so it is important to achieve balance in one's life. For many years, we have organized numerous activities to bring residents and faculty together outside the hospital and university setting. These activities have included a variety of extracurricular events such as hockey, golf, skiing, and curling. In addition, for the past 10 years, I have taken residents and faculty in our program on an annual canoe trip into the wilderness of northern Ontario to provincial parks such as Killarney, Algonquin, the French River, and Temagami (Figure 19). These trips have provided among the most memorable experiences I have enjoyed as chairman and have allowed an opportunity to know the residents and faculty in a way that is not possible in the work environment in the hospital.

Conclusions

To achieve excellence in program building in neurosurgery, we should remember and revel in the contributions of our founding members and mentors; we should choose our colleagues and residents wisely; we should be eager participants in community events especially regarding neurosurgical causes; we should set the bar high and encourage others to reach for it; we should celebrate when we have victories; we should recognize and reward excellence; we should brand our programs and be proud of the brand; and finally, if we truly want to pursue excellence, we should surround ourselves with excellence.

I have indeed been fortunate to have been surrounded by excellence in the neurosurgery residency program with the expert assistance I have received from Dr Chris Wallace, program director. I have enjoyed excellence in the camaraderie of my confidant extraordinaire, Dr Drake, and my other colleagues at the Hospital for Sick Children: Drs Dirks, Kulkarni, and Taylor, who have enabled me to have the time to pursue excellence in all that I do. I have also been extremely fortunate to have excellence in administrative assistance in my clinical office through the help of Madaline Perrino; in the chairman's office through the assistance of Stephanie Nielsen; in the research lab with the assistance of Jean Crispin; and at Sick Kids in the Division of Neurosurgery with the assistance of Anne McKenzie.

In conclusion, it has been my great pleasure to be the honored guest at the Congress of Neurological Surgeons Annual Meeting this year in New Orleans. I should like to conclude by thanking this year's Congress of Neurological Surgeons President, Dr David Adelson; the Annual Meeting chair, Dr Nate Selden; and the Scientific Program Committee co-chairs, Drs Ali Rezai and Russell Lonser, with whom I worked closely to help build on the theme of a Culture of Excellence in Neurosurgery.

Disclosure

This work was made possible through the support of Brainchild and the Jack Beqaj, the Wiley, the Laurie Berman funds for research at the Hospital for Sick Children. The author has no personal financial or institutional interest in any of the drugs, materials, or devices described in this article.

REFERENCES

1. Drake CG, McKenzie KG. Mesencephalic tractotomy for pain: experience with 6 cases. *J Neurosurg*. 1953;10:457-462.
2. McKenzie KG. Intrameningeal division of the spinal accessory and roots of the upper cervical nerves for the treatment of spasmodic torticollis. *Surg Gynecol Obset*. 1924;39:5-10.
3. McKenzie KG. Glioblastoma: a point of view concerning treatment. *Arch Neurol Psychiatry*. 1936;36:369-381.
4. McKenzie KG. The surgical treatment of spasmodic torticollis. *Clin Neurosurg*. 1955;2:37-43.
5. Botterell EH. Strokes as a neurosurgeon sees them. *Postgrad Med*. 1959; 26:413-417.
6. Botterell EH, Callaghan JC, Jousse AT. Pain in paraplegia; clinical management and surgical treatment. *Proc R Soc Med*. 1954;47(4): 281-288.
7. Botterell EH, Fitzgerald GW. Spinal cord compression produced by extradural malignant tumours; early recognition, treatment and results. *Can Med Assoc J*. 1959;80(10):791-796.
8. Botterell EH, Jousse AT. The results of treatment of paraplegics and the future of paraplegic centers. *Treat Serv Bull*. 1948;3(2):11-18.
9. Botterell EH, Lougheed WM, Morley TP, Vandewater SL. Hypothermia in the surgical treatment of ruptured in transcranial aneurysms. *J Neurosurg*. 1958;15(1):4-18.
10. Botterell EH, Lougheed WM, Scott JW, Vandewater SL. Hypothermia, and interruption of carotid, or carotid and vertebral circulation, in the surgical management of intracranial aneurysms. *J Neurosurg*. 1956; 13(1):1-42.
11. Morley TP. Congenital rotation of the spinal cord. *J Neurosurg*. 1953; 10:690-692.
12. Morley TP. The importance of the lateral extensions of the spenoidal sinus in post-traumatic cerebrospinal rhinorrhoea and meningitis: clinical and radiological aspects. *J Neurosurg* 1965;22:326-332.
13. Bratton BR, Kline DG, Coleman W, Hudson AR. Experimental interfascicular nerve grafting. *J Neurosurg*. 1979;51(3):323-332.
14. Hudson AR, Kline DG. Progression of partial experimental injury to peripheral nerve, part 2: light and electron microscopic studies. *J Neurosurg*. 1975;42(1):15-22.
15. Hudson AR, Wissinger JP, Salazar JL, et al. Carpal tunnel syndrome. *Surg Neurol*. 1997;47(2):105-114.
16. Kline DG, Hudson AR. Selected recent advances in peripheral nerve injury research. *Surg Neurol*. 1985;24(4):371-376.
17. Kline DG, Hudson AR. Coaptation of anterior rami of C-3 and C-4. *J Neurosurg*. 1991;75(4):667-668.
18. Kline DG, Hudson AR. Vertebral artery compression. *J Neurosurg*. 1995;83:759.
19. Kline DG, Hudson AR. Diagnosis of root avulsions. *J Neurosurg*. 1997; 87:483-484.
20. Kline DG, Hudson AR, Bratton BR. Experimental study of fascicular nerve repair with and without epineurial closure. *J Neurosurg*. 1981; 54(4):513-520.
21. Kline DG, Hudson AR, Hackett ER, Bratton BR. Progression of partial experimental injury to peripheral nerve. Part 1: periodic measurements of muscle contraction strength. *J Neurosurg*. 1975;42(1):1-14.
22. Kline DG, Hudson AR, Zager E. Selection and preoperative work-up for peripheral nerve surgery. *Clin Neurosurg*. 1992;39:8-35.
23. Kline DG, Reeves J, El-Gindi S, et al. Treatment of ulnar neuropathy. *Surg Neurol*. 2000;53(6):524-529.
24. Parr AM, Kulbatski I, Tator CH. Transplantation of adult rat spinal cord stem/progenitor cells for spinal cord injury. *J Neurotrauma*. 2007;24(5): 835-845.
25. Parr AM, Kulbatski I, Wang XH, Keating A, Tator CH. Fate of transplanted adult neural stem/progenitor cells and bone marrow-derived mesenchymal stromal cells in the injured adult rat spinal cord and impact on functional recovery. *Surg Neurol*. 2008;70(6):600-607.
26. Parr AM, Kulbatski I, Zahir T, et al. Transplanted adult spinal cord-derived neural stem/progenitor cells promote early functional recovery after rat spinal cord injury. *Neuroscience*. 2008;155(3):760-770.
27. Tator CH. The stimulus for an acute spinal cord injury unit. *Can J Neurol Sci*. 1999;26(3):239-241.
28. Tator CH. Strategies for recovery and regeneration after brain and spinal cord injury. *Inj Prev*. 2002;8(Suppl 4):IV33-IV36.
29. Tator CH. Phase 1 trial of oscillating field stimulation for complete spinal cord injury in humans. *J Neurosurg Spine*. 2005;2(1):1.
30. Tator CH. Importance of registering clinical trials. *J Am Coll Surg*. 2006; 203(1):140-141.
31. Tator CH. Review of treatment trials in human spinal cord injury: issues, difficulties, and recommendations. *Neurosurgery*. 2006;59(5):957-982.
32. Tator CH. Recognition and management of spinal cord injuries in sports and recreation. *Neurol Clin*. 2008;26(1):79-88; viii.
33. Tator CH. Injury prevention in the classroom: you only get one brain. *Can J Neurol Sci*. 2009;36(6):675-676.
34. Tator CH. Let's standardize the definition of concussion and get reliable incidence data. *Can J Neurol Sci*. 2009;36(4):405-406.
35. Tator CH, Fehlings MG. Review of clinical trials of neuroprotection in acute spinal cord injury. *Neurosurg Focus*. 1999;6(1):e8.
36. Tator CH, Fehlings MG, Thorpe K, Taylor W. Current use and timing of spinal surgery for management of acute spinal surgery for management of acute spinal cord injury in North America: results of a retrospective multicenter study. *J Neurosurg*. 1999;91(1)(Suppl):12-18.
37. Tator CH, Provvidenza CF, Lapczak L, Carson J, Raymond D. Spinal injuries in Canadian ice hockey: documentation of injuries sustained from 1943-1999. *Can J Neurol Sci*. 2004;31(4):460-466.
38. Tsai EC, Dalton PD, Shoichet MS, Tator CH. Synthetic hydrogel guidance channels facilitate regeneration of adult rat brainstem motor axons after complete spinal cord transection. *J Neurotrauma*. 2004; 21(6):789-804.
39. Tsai EC, Dalton PD, Shoichet MS, Tator CH. Matrix inclusion within synthetic hydrogel guidance channels improves specific supraspinal and local axonal regeneration after complete spinal cord transection. *Biomaterials*. 2006;27(3):519-533.
40. Tsai EC, Krassioukov AV, Tator CH. Corticospinal regeneration into lumbar grey matter correlates with locomotor recovery after complete spinal cord transection and repair with peripheral nerve grafts, fibroblast growth factor 1, fibrin glue, and spinal fusion. *J Neuropathol Exp Neurol*. 2005;64(3):230-244.
41. Tsai EC, van Bendegem RL, Hwang SW, Tator CH. A novel method for simultaneous anterograde and retrograde labeling of spinal cord motor tracts in the same animal. *J Histochem Cytochem*. 2001;(49): 1111-1122.
42. Hendrick EB, Hoffman HJ, Humphreys RP. Trauma of the central nervous system in children. *Pediatr Clin North Am*. 1975;22(2):415-424.
43. Hendrick EB, Hoffman HJ, Humphreys RP. The tethered spinal cord. *Clin Neurosurg*. 1983;30:457-463.
44. Hoffman HJ, Chuang S, Hendrick EB, Humphreys RP. Aneurysms of the vein of Galen: experience at the Hospital for Sick Children, Toronto. *J Neurosurg*. 1982;57(3):316-322.

45. Hoffman HJ, Hendrick EB, Humphreys RP. Manifestations and management of Arnold-Chiari malformation in patients with myelomeningocele. *Childs Brain*. 1975;1(4):255-259.
46. Hoffman HJ, Hendrick EB, Humphreys RP. Metastasis via ventriculoperitoneal shunt in patients with medulloblastoma. *J Neurosurg*. 1976; 44(5):562-566.
47. Hoffman HJ, Hendrick EB, Humphreys RP. New lumboperitoneal shunt for communicating hydrocephalus; technical note. *J Neurosurg*. 1976; 44(2):258-261.
48. Hoffman HJ, Hendrick EB, Humphreys RP. The tethered spinal cord: its protean manifestations, diagnosis and surgical correction. *Childs Brain*. 1976;2(3):145-155.
49. Hoffman HJ, Hendrick EB, Humphreys RP. Experience with ventriculo-pleural shunts. *Childs Brain*. 1983;10(6):404-413.
50. Hoffman HJ, Hendrick EB, Humphreys RP. Management of medulloblastoma in childhood. *Clin Neurosurg*. 1983;30:226-245.
51. Hoffman HJ, Hendrick EB, Humphreys RP, Armstrong EA. Investigation and management of suprasellar arachnoid cysts. *J Neurosurg*. 1982; 57(5):597-602.
52. Hoffman HJ, Hendrick EB, Humphreys RP, Buncic JR, Armstrong DL, Jenkin RD. Management of craniopharyngioma in children. *J Neurosurg*. 1977;47:218-227.
53. Hoffman HJ, Neill J, Crone KR, Hendrick EB, Humphreys RP. Hydrosyringomyelia and its management in childhood. *Neurosurgery*. 1987;21(3):347-351.
54. Hoffman HJ, Otsubo H, Hendrick EB, et al. Intracranial germ-cell tumors in children. *J Neurosurg*. 1991;74:545-551.
55. Hoffman HJ, Taecholarn C, Hendrick EB, Humphreys RP. Management of lipomyelomeningoceles: experience at the Hospital for Sick Children, Toronto. *J Neurosurg*. 1985;62(1):1-8.
56. Hoffman HJ, Yoshida M, Becker LE, Hendrick EB, Humphreys RP. Experience with pineal region tumours in childhood. *Neurol Res*. 1984; 6(3):107-112.
57. Hoffman HJ, Yoshida M, Becker LE, Hendrick EB, Humphreys RP. Pineal region tumors in childhood: experience at the Hospital for Sick Children, 1983. *Pediatr Neurosurg*. 1994;21(1):91-103.
58. Humphreys RP, Creighton RE, Hendrick EB, Hoffman HJ. Advantages of the prone position for neurosurgical procedures on the upper cervical spine and posterior cranial fossa in children. *Childs Brain*. 1975;1(6): 325-336.
59. Humphreys RP, Gilday DL, Ash JM, Hendrick EB, Hoffman HJ. Radiopharmaceutical bone scanning in pediatric neurosurgery. *Childs Brain*. 1979;5(3):249-262.
60. Humphreys RP, Hendrick EB, Hoffman HJ. Cerebrovascular disease in children. *Can Med Assoc J*. 1972;107:774-776.
61. Humphreys RP, Hendrick EB, Hoffman HJ. Diastematomyelia. *Clin Neurosurg*. 1983;30:436-456.
62. Humphreys RP, Hendrick EB, Hoffman HJ. Arteriovenous malformations of the brainstem in childhood. *Childs Brain*. 1984;11(1):1-11.
63. Humphreys RP, Hendrick EB, Hoffman HJ. The head-injured child who ''talks and dies'': A report of 4 cases. *Childs Nerv Syst*. 1990;6(3): 139-142.
64. Humphreys RP, Hoffman HJ, Hendrick EB. A long-term postoperative follow-up in craniopharyngioma. *Childs Brain*. 1979;5(6):530-539.
65. Kondziolka D, Humphreys RP, Hoffman HJ, Hendrick EB, Drake JM. Arteriovenous malformations of the brain in children: a forty year experience. *Can J Neurol Sci*. 1992;19(1):40-45.
66. Park TS, Hoffman HJ, Hendrick EB, Humphreys RP. Experience with surgical decompression of the Arnold-Chiari malformation in young infants with myelomeningocele. *Neurosurgery*. 1983;13(2): 147-152.
67. Park TS, Hoffman HJ, Hendrick EB, Humphreys RP, Becker LE. Medulloblastoma: clinical presentation and management: experience at the hospital for sick children, Toronto, 1950-1980. *J Neurosurg*. 1983; 58(4):543-552.
68. Stroink AR, Hoffman HJ, Hendrick EB, Humphreys RP, Davidson G. Transependymal benign dorsally exophytic brain stem gliomas in childhood: diagnosis and treatment recommendations. *Neurosurgery*. 1987;20(3):439-444.
69. Hoffman HJ. Surgical management of craniopharyngioma. *Pediatr Neurosurg*. 1994;21(Suppl 1):44-49.
70. Rutka JT, Souweidane M, ter Brugge K, et al. Separation of craniopagus twins in the era of modern neuroimaging, interventional neuroradiology, and frameless stereotaxy. *Childs Nerv Syst*. 2004;20(8-9):587-592.
71. Drake JM, Joy M, Goldenberg A, Kreindler D. Computer- and robot-assisted resection of thalamic astrocytomas in children. *Neurosurgery*. 1991;29(1):27-33.
72. Drake JM, Prudencio J, Holowaka S, Rutka JT, Hoffman HJ, Humphreys RP. Frameless stereotaxy in children. *Pediatr Neurosurg*. 1994;20(2):152-159.
73. Drake JM, Kestle J. Determining the best cerebrospinal fluid shunt valve design: the pediatric valve design trial. *Neurosurgery*. 1996;38(3):604-607.
74. Drake JM, Kestle J. Rationale and methodology of the multicenter pediatric cerebrospinal fluid shunt design trial: Pediatric Hydrocephalus Treatment Evaluation Group. *Childs Nerv Syst*. 1996;12(8):434-447.
75. Drake JM, Kestle JR, Milner R, et al. Randomized trial of cerebrospinal fluid shunt valve design in pediatric hydrocephalus. *Neurosurgery*. 1998;43(2):294-303.
76. Drake JM, Kestle JR, Tuli S. Cerebrospinal fluid shunt technology. *Clin Neurosurg*. 2000;47:336-345.
77. Drake JM, Kestle JT. Determining the best cerebrospinal fluid shunt valve design: the pediatric valve design trial. *Neurosurgery*. 1998;43(5): 1259-1260.
78. Drake JM, Tenti G, Sivalsganathan S. Computer modeling of siphoning for CSF shunt design evaluation. *Pediatr Neurosurg*. 1994;21(1):6-15.
79. Drake JM, Kulkarni AV, Kestle J. Endoscopic third ventriculostomy versus ventriculoperitoneal shunt in pediatric patients: a decision analysis. *Childs Nerv Syst*. 2009;25(4):467-472.
80. Singh S, Dirks PB. Brain tumor stem cells: identification and concepts. *Neurosurg Clin N Am*. 2007;18(1):31-38, viii.
81. Singh SK, Clarke ID, Hide T, Dirks PB. Cancer stem cells in nervous system tumors. *Oncogene*. 2004;23(43):7267-7273.
82. Singh SK, Clarke ID, Terasaki M, et al. Identification of a cancer stem cell in human brain tumors. *Cancer Res*. 2003;63(18):5821-5828.
83. Singh SK, Hawkins C, Clarke ID, et al. Identification of human brain tumour initiating cells. *Nature*. 2004;432(7015):396-401.
84. Dirks PB. Cancer: stem cells and brain tumours. *Nature*. 2006; 444(7120):687-688.
85. Dirks PB. Brain tumor stem cells: bringing order to the chaos of brain cancer. *J Clin Oncol*. 2008;26(17):2916-2924.
86. Dirks PB. Brain tumour stem cells: the undercurrents of human brain cancer and their relationship to neural stem cells. *Philos Trans R Soc Lond B Biol Sci*. 2008;363(1489):139-152.
87. Dirks PB. Cancer's source in the peripheral nervous system. *Nat Med*. 2008;14(4):373-375.
88. Dirks PB. MicroRNAs and parallel stem cell lives. *Cell*. 2009;138(3): 423-424.
89. Kulkarni AV, Aziz B, Shams I, Busse JW. Comparisons of citations in Web of Science, Scopus, and Google Scholar for articles published in general medical journals. *JAMA*. 2009;302(10):1092-1096.
90. Kulkarni AV, Drake JM, Mallucci CL, Sgouros S, Roth J, Constantini S. Endoscopic third ventriculostomy in the treatment of childhood hydrocephalus. *J Pediatr*. 2009;155(2):254e.1-259.e1.
91. Kulkarni AV, Drake JM, Rabin D, Dirks PB, Humphreys RP, Rutka JT. Measuring the health status of children with hydrocephalus by using a new outcome measure. *J Neurosurg*. 2004;101(2)(Suppl):141-146.

92. Kulkarni AV, Hui S, Shams I, Donnelly R. Quality of life in obstructive hydrocephalus: endoscopic third ventriculostomy compared to cerebrospinal fluid shunt. *Childs Nerv Syst*. 2010;26(10):75-79.
93. Kulkarni AV, Rabin D, Drake JM. An instrument to measure the health status in children with hydrocephalus: the Hydrocephalus Outcome Questionnaire. *J Neurosurg*. 2004;101(2)(Suppl):134-140.
94. Kulkarni AV, Shams I. Quality of life in children with hydrocephalus: results from the Hospital for Sick Children, Toronto. *J Neurosurg*. 2007;107(5)(Suppl):358-364.
95. Northcott PA, Fernandez LA, Hagan JP, et al. The miR-17/92 polycistron is up-regulated in sonic hedgehog-driven medulloblastomas and induced by N-myc in sonic hedgehog-treated cerebellar neural precursors. *Cancer Res*. 2009;69(8):3249-3255.
96. Northcott PA, Nakahara Y, Wu X, et al. Multiple recurrent genetic events converge on control of histone lysine methylation in medulloblastoma. *Nat Genet*. 2009;41(4):465-472.
97. Taylor MD, Gokgoz N, Andrulis IL, Mainprize TG, Drake JM, Rutka JT. Familial posterior fossa brain tumors of infancy secondary to germline mutation of the hSNF5 gene. *Am J Hum Genet*. 2000;66(4):1403-1406.
98. Taylor MD, Liu L, Raffel C, et al. Mutations in SUFU predispose to medulloblastoma. *Nat Genet*. 2002;31(3):306-310.
99. Taylor MD, Mainprize TG, Rutka JT. Molecular insight into medulloblastoma and central nervous system primitive neuroectodermal tumor biology from hereditary syndromes: a review. *Neurosurgery*. 2000;47(4):888-901.
100. Taylor MD, Mainprize TG, Rutka JT. Bioinformatics in neurosurgery. *Neurosurgery*. 2003;52:723-730.
101. Taylor MD, Mainprize TG, Rutka JT, Becker L, Bayani J, Drake JM. Medulloblastoma in a child with Rubenstein-Taybi syndrome: case report and review of the literature. *Pediatr Neurosurg*. 2001;35(5):235-238.
102. Taylor MD, Mainprize TG, Squire JA, Rutka JT. Molecular genetics of pineal region neoplasms. *J Neurooncol*. 2001;54(3):219-238.
103. Taylor MD, Zhang X, Liu L, et al. Failure of a medulloblastoma-derived mutant of SUFU to suppress WNT signaling. *Oncogene*. 2004;23(26):4577-4583.
104. Jea A, Al-Otibi M, Rutka JT, et al. The history of neurosurgery at the Hospital for Sick Children in Toronto. *Neurosurgery*. 2007;61(3):612-624.
105. Zadeh G, Qian B, Okhowat A, Sabha N, Kontos CD, Guha A. Targeting the Tie2/Tek receptor in astrocytomas. *Am J Pathol*. 2004;164(2):467-476.
106. Kongkham PN, Northcott PA, Ra YS, et al. An epigenetic genome-wide screen identifies SPINT2 as a novel tumor suppressor gene in pediatric medulloblastoma. *Cancer Res*. 2008;68(23):9945-9953.

