shine

Fall 2024

The universe within us

Radical approaches to understanding the biggest mystery of all: the brain

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Inside the daring journey to transform epilepsy care

Moving sleep studies to the comfort of kids' homes

How mini brains are revealing the drivers of rare neurological disorders

BC Children's Hospital Foundation

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The body's final frontier

The brain is an extraordinary thing. It contains 400 miles of blood vessels, over 3,000 types of cells, and a hundred billion neurons linked by trillions of connections. Its complexity is so vast that you'd need to venture to the stars to find a worthy comparison. It makes you wonder: can our brains ever truly comprehend their own intricacies?

Across our hospital campus, daring minds are rising to the challenge. Undeterred by the complexity of this organ—and fuelled by the generosity of donors—they are unlocking the brain's secrets and overturning long-held beliefs. For instance, researchers are looking deeper into the biological drivers of mental health conditions, advancing our understanding of the profound connection between mental and brain health.

Decoding the mind is no small task—and it can't be done alone. As you'll see, disciplines once separated are now coming together, from psychiatrists to neurosurgeons and neuroscientists. This integration is bridging the gap between research and care, shattering stigmas and opening doors to novel treatments for some of the toughest neurological and psychiatric conditions facing kids.

In this issue of *Shine*, we invite you to explore the fascinating world of the human brain and meet the experts reshaping our understanding of it. With the brain's remarkable plasticity in children—where neural pathways can be rewired—we have a unique opportunity to confront conditions once deemed incurable, transform countless lives and shape the health of an entire generation.

We're incredibly grateful to have you on this journey with us.

With gratitude,

Malcolm Berry
President & CEO
BC Children's Hospital Foundation

Out of the Dark

Gaze up at the night sky, and the seemingly infinite number of stars scattered across its vast canvas can leave you in awe. Remarkably, trillions of miles closer lies something even more intricate: the human brain.

These two wildly different systems—the universe and the brain—are the most complex known to humankind. While significant progress has been made in exploring a galaxy that stretches 100,000 light-years across, the three-pound mass tucked inside our heads has remained far more mysterious. Treatments for childhood brain conditions have long lagged behind those for diseases like cancer and heart disease. Yet, this organ is central to everything we are—regulating bodily functions, shaping our thoughts and defining our very essence.

The brain is both medicine's greatest challenge and its final frontier. That's why medical experts across BC Children's Hospital are radically rethinking how they confront its varied conditions. Their ability to treat them is dramatically better than it was just years ago—and the future holds even greater promise. With each discovery, they're moving closer to revealing the brain's deepest secrets.

"The brain, a three-pound marvel, contains nearly 100 billion neurons that form more than 100 trillion connections—far more than the number of stars in the Milky Way."

— Dr. Steven Miller

Dr. Tamara Vanderwal

UNCOVERING THE BIOLOGICAL ROOTS OF MENTAL HEALTH CONDITIONS

If a child breaks a bone or has a suspected heart condition, scans or tests can usually pinpoint the problem, leading to a treatment plan. Mental health conditions, however, are a different story.

"One of the most frustrating aspects of mental health care is that there isn't a single biologically-based test to diagnose conditions," said Dr. Tamara Vanderwal, a researcher and child psychiatrist at BC Children's Hospital. "In this way, mental health care stands apart from every other field of medicine."

Traditionally, doctors have relied on patient and family self-reports and their own clinical experiences to diagnose mental health conditions and choose treatments. This subjective approach leads to complicated and sometimes long trials of different treatments—leaving many children's mental health needs unmet.

But change is on the horizon. Thanks to cutting-edge imaging technologies, funded by donors, medical experts can now observe the brain in action with unprecedented detail. This has allowed Dr. Vanderwal to develop a novel way to study mental health conditions: showing movies inside functional MRI scanners. Why movies? As she explains, they engage children's brains, providing a dynamic way to see how the organ processes unfolding emotions, stories and sounds.

"Think of it like a cardiac stress test," Dr. Vanderwal said. "Just as doctors assess heart function by making it work on a treadmill, we use movies to stimulate brain activity and observe the brain in action. We think this could help us see the biological changes in children's brains that underlie mental health symptoms, potentially leading to more accurate diagnoses and better treatments."

The team has recently launched a new collaborative study to examine what changes occur in the brains of female adolescents with depression when their symptoms improve. This alone is a big undertaking, but Dr. Vanderwal's plans are even more ambitious. She envisions a future where brain scans could detect a child's risk of developing a mental health condition—before symptoms strike.

"If we can identify high-risk children early, we could intervene with support or treatment and potentially alter their developmental path," added Dr. Vanderwal. "This kind of work is still a ways off, but it's within the realm of possibility."

Meanwhile, Dr. Evelyn Stewart, Director of Research for Child and Adolescent Psychiatry and Congdon Family Hospital Chair in Child and Youth Mental Health Research at BC Children's Hospital, is studying lab tests using saliva and cheek swab samples to measure the body's state of inflammation—along with the "on" or "off" state of differing genes relevant to brain functioning—to gauge how mental health treatments are working. In a pilot study on pediatric obsessive-compulsive disorder, these biomarkers were tracked to assess biological change before and after cognitive behavioural therapy.

Along with helping to understand how this non-medication treatment approach works in the brain, this could identify which children are best served by this treatment. A larger follow-up study will soon explore changes of these and other biomarkers across OCD and a host of other mental health conditions following cognitive behavioural therapy.

"If we can identify high-risk children early, we could intervene with support or treatment and potentially alter their developmental path."
— Dr. Tamara Vanderwal

Direct brain manipulation is another exciting advancement. One innovative approach is repetitive transcranial magnetic stimulation, or rTMS—which acts like a pacemaker for the brain. This technique uses strong magnets to target and stimulate specific brain circuits to treat mental health conditions with remarkable precision.

Experts at BC Children's Hospital are preparing to begin studying the effects of rTMS. Because developing brains are more plastic—meaning they are naturally able to form new connections and even new structures more quickly—there's already promising data revealing its potential for treating adolescents with depression who don't respond to traditional approaches.

THE MIND AND BODY AS ONE

This groundbreaking work underscores an important realization in medicine: mental health and brain health are deeply interconnected. For years, a gap between neurology and psychiatry has persisted. Closing this divide can revolutionize the way brain-related conditions are treated. While environmental and social factors contribute to mental health, understanding its biological roots is equally crucial. It provides both certainty and precision, something that's incredibly valuable when navigating the intricate and elusive nature of the brain.

"One of the barriers to progress is this idea that the mind is separate from the body," explained Dr. Steven Miller, Head of the Department of Pediatrics at UBC and BC Children's Hospital and Hudson Family Hospital Chair in Pediatric Medicine at BC Children's Hospital. "Yet, our brains shape who we are. If we have a change in our mental health, cognition or even language or motor skills, there's a change in the brain. If we can better understand those changes, we can develop better approaches to tackle some of the biggest health challenges facing kids."

SHAPING THE FUTURE OF BRAIN HEALTH

The way forward in realizing this daring future will require an integrated approach. Given the brain's complexity, it demands close collaboration among multiple medical specialties—psychiatrists, neurologists, neurosurgeons, psychologists, child life specialists and social workers—working alongside neuroscience researchers who are developing the best evidence to bring to kids' bedsides.

This work is especially crucial for children, as the foundation for lifelong brain health is laid in the earliest years. Kids' brains are remarkably malleable—capable of changing, growing and adapting in ways far greater than an adult's. A well-timed intervention can have a ripple effect that lasts an entire lifetime. Fortunately, brilliant minds across our campus are making extraordinary leaps in unravelling this vast and intricate universe within us.

Dr. Evelyn Stewart

L to R: Dr. Ash Singhal, Dr. Ananth Abraham and Winnie Tong (RN) simulating a procedure on a training model

A Journey to the Brain's Depths

FROM ROBOTS TO LASERS, A BOLD FUTURE IN EPILEPSY CARE

For children with uncontrolled epilepsy, each day can be overshadowed by the looming threat of a seizure. Simple joys like playing with friends are daunting. Going to school often triggers anxiety. Riding a bike and learning to swim become activities filled with fear. For their families, this means constant vigilance—always on edge, waiting.

Traditional treatments, which range from anti-seizure medications to high-fat diets and surgery, have improved the lives of many children and youth. But for many of the 30% who live with intractable epilepsy, these measures fall short. Today, advanced tools—including surgical robots, precision lasers and genetic research—allow medical experts to venture into the brain in ways that once seemed like science fiction.

FINDING WHAT LIES BENEATH

Uncontrolled epilepsy is often caused by small areas of abnormal brain development. Pinpointing the exact spot that triggers seizures is incredibly difficult in something as complex as the brain. Removing it poses an even bigger obstacle.

"A big problem with the brain is getting to where you need to be," explained Dr. Ash Singhal, Division Head of Pediatric Neurosurgery at BC Children's Hospital. "It's like journeying to the centre of the Earth. Traditionally, you'd have to dig a big hole to get there. But now, we have microscopic approaches that allow us to avoid large excavations."

These advances have transformed the landscape of epilepsy care. What once required large incisions, lengthy hospital stays and considerable risk is now done with tiny incisions, shorter stays and lower risk. One such innovation already making a difference is surgeon-guided robotics.

Five years ago, generous donor support allowed BC Children's Hospital to introduce a neurosurgical navigation system. It functions like a GPS for the brain—allowing surgeons to place EEG electrodes that measure brain activity, identify the seizure source and map out a surgical path with millimeter precision. Its "arms" can also attach miniature instruments, such as cameras, providing unparalleled visibility into the brain's hidden depths.

This technology has already propelled epilepsy surgery lightyears ahead. We are now working to bring another transformative change, called laser interstitial thermal therapy (LITT), to BC's kids. Like many medical breakthroughs, it builds on the foundations of past advances. Once the problem area in the brain is located, LITT uses a tiny probe—no larger than a piece of spaghetti—that gently heats yet powerfully destroys the seizure-causing tissue.

INNOVATIONS

"It's like journeying to the centre of the Earth. Traditionally, you'd have to dig a big hole to get there. But now, we have microscopic approaches that allow us to avoid large excavations."

— Dr. Ash Singhal

L to R: Dr. Ananth Abraham and Dr. Ash Singhal demonstrating equipment

"These advances will allow us to diagnose and treat epilepsy with one single hospital stay," said Dr. Singhal. "In the near future at BC Children's Hospital, a child will go home with a few small incisions, wondering if they actually had brain surgery."

Responsive neurostimulation therapy is another promising development that experts hope to bring to our province's children in the next couple of years. Used in patients with epilepsy that originates in parts of the brain too risky to remove, like the language networks or areas controlling hand function, the implanted device constantly records a child's brain waves. At the first signs of a seizure—often before kids realize they are having one—it sends electrical impulses that stop them in their tracks.

DIGGING DEEPER FOR ANSWERS

Surgery is just one part of this bold future. Research plays an equally crucial role. At BC Children's, innovative studies are uncovering the genetic links to epilepsy, providing new clues into its causes and opening the door to more targeted treatments.

"There are over 800 genes linked to epilepsy," said Dr. Mary Connolly, Director of the Epilepsy Program. "By pinpointing the exact genetic cause in a child, in some instances, we can determine which treatments are likely to be most effective or develop a personalized approach. For example, certain genes suggest that specific anti-seizures medications should be avoided or another treatment is more likely to be effective, such as the ketogenic diet or a medication not typically used to treat epilepsy."

THE QUEST CONTINUES

With these scientific and medical advancements, even children and youth with the most difficult to control forms of epilepsy are becoming treatable. While there's no telling just how far treatments will evolve in the years to come, one thing is certain—these developments promise to revolutionize epilepsy care as we know it.✸

Nimrit, age 12, with neurology nurse clinician, Jocelyn Collin, in the Epilepsy Monitoring Unit

Alex, age 12, with home sleep sensors (L) and wearing the positional sleep belt (R)

A New Chapter in Sleep Studies

BRINGING THE SLEEP LAB HOME

Sleep is inextricably tied to brain health. For some concerned families, a sleep study can help reveal a condition that's impacting their child's behaviour and development. For others, it might pinpoint a life-threatening diagnosis.

Twenty years ago, respirologist Dr. David Wensley developed the Sleep Lab at BC Children's Hospital. It was, and still is, the province's only dedicated service that monitors sleep to diagnose disorders in children—disorders like sleep apnea, insomnia, and potentially lethal conditions like congenital central hypoventilation syndrome. Over the years, the Sleep Lab has expanded to perform almost 500 studies per year, and has helped thousands of kids across BC. Now, the Sleep Lab team is working towards an ambitious new goal: conducting sleep studies in patient homes.

"With an in-hospital sleep clinic, kids are in an unfamiliar environment with a jumble of wires attached to them," explained Dr. Wensley. "Then they're told to sleep like they normally do. It isn't an easy task." But taking sleep studies from a hospital room to a bedroom is no easy task either. Children are physiologically different from adults, and this includes how they sleep. Existing strategies and equipment used for adult at-home sleep studies simply do not translate.

There's a lot to work out: can we use depth sensing cameras to measure breathing? What would a wearable, wireless EEG look like? And how can we repurpose existing at-home sleep devices?

"We know devices like Fitbits underrepresent children's sleep," said Dr. Wensley. "Right now, we're recalibrating these devices to work for kids." The progress taking place has been incredibly promising. While the Sleep Lab has been transformational in its own right, Sleep Lab at Home will have a new, exciting impact on BC families who have historically needed to make a long trek—or flight—to the hospital for a sleep study.

A BELT THAT'S GOT YOUR BACK

Dr. Lena Xiao, a respirologist with the Sleep Lab, is pursuing novel therapies and care pathways for children who need to use breathing machines while sleeping. One area of her work even asks the question: what if some children didn't need to use a breathing machine at all?

"I'm evaluating a positional sleep belt for children," Dr. Xiao explained. "This is specifically for kids with sleep apnea who have breathing issues while on their back. The sleep belt has a cushion that prevents the child from sleeping on their back, ensuring they breathe normally throughout the night." While simple, this could have an incredible impact on families dealing with sleep apnea. "It's not easy to get a toddler to use a breathing machine, as you can imagine," said Dr. Xiao. "But sleep health is necessary for brain health. I'm hoping this new device can help families who are struggling."✸

Making Moves

When supporting kids with mobility challenges, clinicians across the hospital often turn to one powerful resource: The Motion Lab. Here, a specialized team quantifies kids' abilities to move and function, addressing conditions that range from cerebral palsy to traumatic injuries.

RETHINKING MOTION CAPTURE

The Motion Lab uses advanced motion capture technology that tracks every step, bend and shift in a child's body. Traditionally, this process involves placing reflective markers on their skin, with cameras positioned throughout the room capturing their movements to create a 3D representation.

"We can see if their ankle doesn't point as much as we want it to or if it points too much," said Dr. Timothy Bhatnagar, Director of The Motion Lab at Sunny Hill Health Centre. "We also analyze their footprint on the floor and how force is distributed."

For some kids, the experience is exciting—like stepping into a video game. But for others, it can feel overwhelming. Recently, The Motion Lab has been testing a promising new system that eliminates the need for stickers on the skin, making it easier for more children to participate while still collecting valuable data.

IMPROVING WALKING BY ROWING

Another initiative at The Motion Lab is supporting kids with cerebral palsy in an unexpected way: water rowing.

"Row to Grow is all about getting kids with cerebral palsy out on the water to row," explained Dr. Bhatnagar. "Anecdotal evidence suggests that not only do kids enjoy it, but they also show improvements in their walking."

This past summer marked the program's inaugural season, and the early results are promising. The team aims to present their initial findings in early 2025, with hopes of expanding the program even further.✸

Reyna, age 5, at a Motion Lab assessment

Finding big answers in mini brains

In his research lab, Dr. Mahmoud Pouladi leans over a microscope, peering into a petri dish filled with tiny, three-dimensional blobs, called brain organoids. These meticulously grown miniature brains are doing something remarkable: helping to solve some of the toughest mysteries surrounding rare neurodevelopmental disorders in children.

For these kids and their families, the journey for a diagnosis can be a long and frustrating one. Many face endless appointments and tests—only to learn that answers for what’s causing their debilitating symptoms can’t be found. Dr. Pouladi is determined to change that.

“We start with a simple blood sample from a child and turn it into stem cells,” he explained. “From there, we can turn them into brain cells that mimic a child’s unique condition. This allows us to observe how normal biology is disrupted and test different treatments before one is given to a child.”

Dr. Pouladi recently became the first in the world to create brain organoids with microglia-like cells, the brain’s resident immune cells. This breakthrough creates a more accurate model of brain disorders, providing deeper insights into how they develop and respond to treatment. Already, it has revealed a potentially promising therapy for fragile X syndrome—the most common genetic cause of intellectual disability and autism spectrum disorder.

Dr. Pouladi’s ultimate goal is to give families the answers they’ve been seeking—answers that can lead to new treatments and bring hope to those navigating the unknown of rare brain disorders.✸

Navigating a perfect storm

Social isolation, disrupted routines and reduced access to in-person care—these were just some of the factors associated with a surge in eating disorders in the wake of the COVID-19 pandemic. For some children, existing conditions worsened, while others faced entirely new challenges.

Across Canada, the rise was concerning. Emergency department visits and hospital admissions for eating disorders like anorexia nervosa increased. In response, the team at BC Children’s quickly mobilized. They set out to offer specialized training in family-based treatment—one of the most effective treatments for pediatric eating disorders—to health care providers across BC and the Yukon. The response was overwhelming: spots for the two-day workshop filled up in hours. Within 12 months, 188 clinicians requested this specialized training. To meet ongoing demand, additional workshops are planned through 2025.

“It demonstrated how urgently health care providers were seeking ways to better support children and families,” said Kim Williams, Program Director of the Provincial Specialized Eating Disorders Program at BC Children’s. “We heard from many of them that they felt significantly more equipped to treat eating disorders after this training.”

The hospital also reimagined its day program, training its team in leading-edge treatments like Dialectical Behaviour Therapy. This form of cognitive behavioural therapy helps kids and families develop new skills and advance their recovery by working toward a life worth living.

Understanding the brain’s role in eating disorders is another aspect of the hospital’s approach to improving care. Researchers joined a national initiative to explore the neurological underpinnings of anorexia nervosa. The study aims to compare brain changes in healthy youth with those recently diagnosed with eating disorders and to understand how the brain recovers with treatment.

“A lot of neuroimaging research in eating disorders focuses on adults, but there’s a critical need to study developing minds and understand the brain processes impacted,” explained Dr. Jennifer Coelho, a psychologist and researcher at BC Children’s Hospital. “This work will bring us closer to precision medicine, allowing us to tailor treatments to each child.”

All these efforts underscore a crucial aspect of mental health care: early intervention. The sooner treatment begins, the better the outcomes—especially for children and teens. Addressing these issues early is essential to prevent them from becoming deeply entrenched.✸

A visit with Dr. Simon Whyte

"Anesthesia is phenomenally safe, but that doesn't mean there's nothing left to do. We can always seek to improve the experience for kids."

— Dr. Simon Whyte

Every year, over 13,000 kids require anesthesia as part of a procedure or surgery at BC Children's Hospital. But to many, the very idea of being "under" anesthetic is a black-box mystery. To delve into the world of anesthesia—how it's tailored for kids, and where the field is headed—we sat down with Dr. Simon Whyte, Head of Pediatric Anesthesiology.

Q: HOW DOES ANESTHETIC CARE DIFFER BETWEEN CHILDREN AND ADULTS?

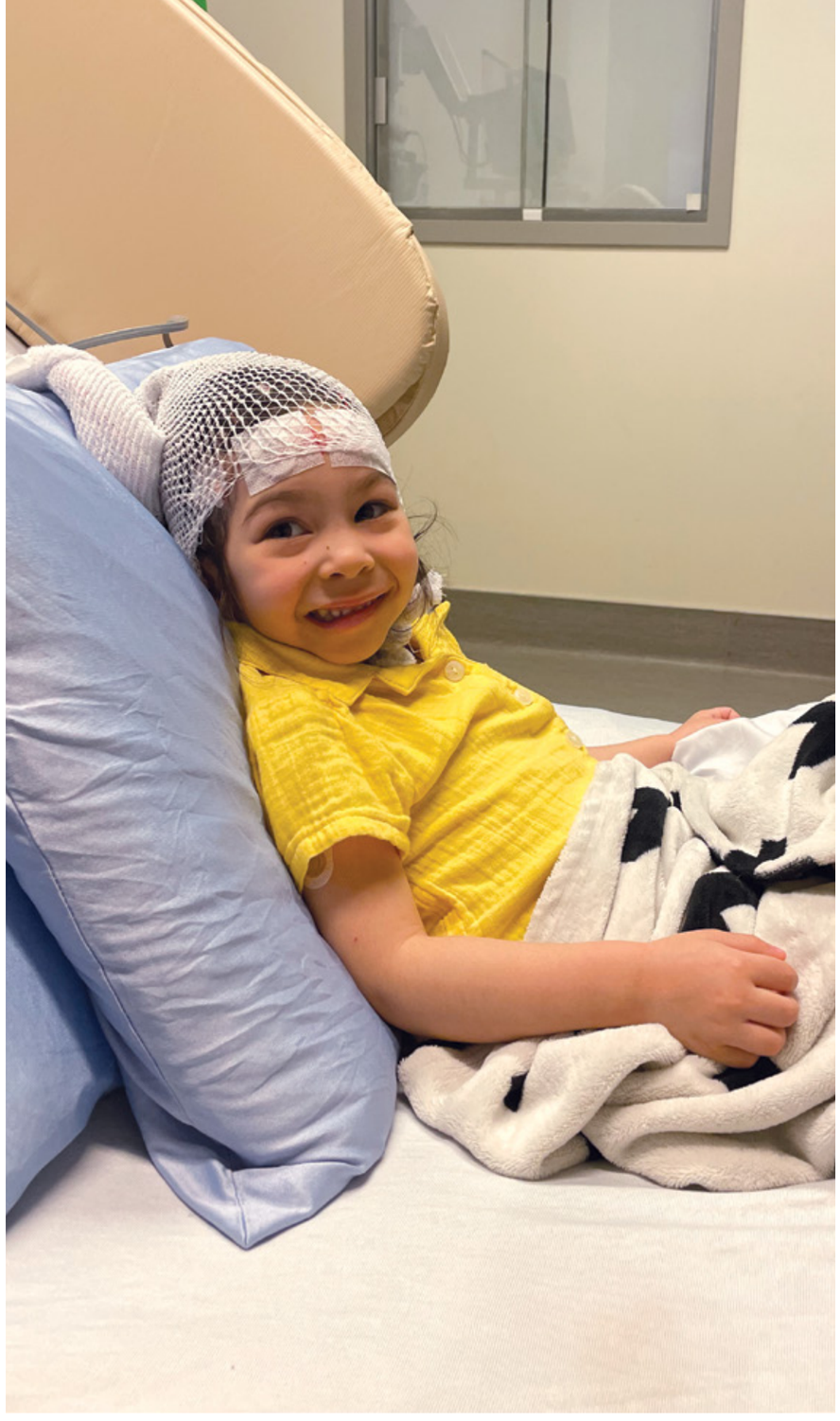
A: In so many ways! Children come in drastically different sizes and physiologies, from tiny newborns to adult-sized teenagers. We need to provide appropriate care for all of them. Kids also have much more limited respiratory reserve than adults, which means their oxygen levels drop much faster when under anesthetic. Because of factors like these, kids have much more variability in anesthetic drug dose requirements. Pediatric anesthesiology is very specialized, for good reason.

Q: CAN YOU TELL US ABOUT SOME OF THE RESEARCH TEAM'S CURRENT INVESTIGATIONS?

A: We've been investigating how genetic factors can help determine the amount of anesthetic children need. Specifically, we're looking at how genetic variation in certain brain receptors might affect how anesthetic medicines work. We're also investigating whether allowing carbon dioxide levels to rise slightly within the body while under anesthesia may reduce the amount of anesthetic a child needs. Trying to achieve the depth of anesthesia you want with the least amount of drug is ideal, because it shortens the child's recovery period.

Q: WHEN YOU THINK ABOUT THE FUTURE OF PEDIATRIC ANESTHESIOLOGY, WHAT COMES TO MIND?

A: Precision medicine hasn't fully arrived in this field, but we're working to change that. The investigation focused on individual genetic factors is a good example of this. There's also a lot to be said for global registries. In the field of anesthesia, refinements in care are mostly about improving already-good outcomes, or addressing rare occurrences, so big databases help us share and compare our learnings with others in our field. Our team recently finished contributing data to a global study on breathing tubes in children. This multinational collaboration will have over 100,000 data points. It's very inspiring, that we're all working together. We have the same goal: improving anesthetic care for kids, everywhere. ✸



6th Floor, Teck Acute Care Centre,
BC Children's Hospital
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"Before Lola's big surgery, our epilepsy nurse clinician introduced us to a family who had been through the same thing. Meeting them gave us a glimpse of what life could be like for Lola in a few years. Their support, their story, helped us see how Lola could gain the same sense of strength and freedom.

This surgery—a functional hemispherotomy to disconnect one side of her brain—would mean a better, seizure-free future was possible for Lola. It changed everything for our girl. She bounced back so quickly, and it's incredible how much she can do with just one hemisphere of her brain. It's further proof that she's truly unstoppable, and we're so proud of her.

There are still many unknowns about raising a child with disabilities, but we take things one day at a time. People often call us strong, but we do what we must for our children, because there is no other choice."

— Bev, Lola's mom

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