TAKING ON TOMORROW
Innovations at Boston Children’s Hospital
CLINICAL INNOVATIONS: Translating discoveries to care
FROM SCIENCE TO CARE: Breakthroughs & discoveries
THE VALUE EQUATION: Measuring cost, quality & service
PROBLEM-SOLVING DEVICES: Leveraging technology to improve care
TRANSLATING INNOVATIONS: Readying ideas for market
DIGITAL RX: Health care goes mobile
GLOBAL & POPULATION HEALTH: Providing care beyond our hospital walls
These are just a few of the innovations you’ll read about in the pages to follow—and as inspiring as they may be, they’re just scratching the surface of the life-changing work in research, innovation and care going on every day at Boston Children’s Hospital.

Although we’re perhaps best known for the quality and safety of the care we deliver, Boston Children’s is so much more than a great pediatric hospital. As home to the world’s largest and most active research enterprise at a pediatric center, we are striving tirelessly to revolutionize medicine, science and care delivery, to create a brighter future for all families, everywhere.

Our culture of innovation crosses all levels of our institution, starting with the researchers, scientists and clinicians who have made it their life’s work to discover and develop new breakthroughs in care. From tiny tools designed to perform non-invasive heart surgery, to longer lasting anesthetics for post-operative pain control, they are never satisfied until they’ve made the impossible possible.

Our caregivers—doctors, nurses, therapists and more—are uniquely positioned to identify the clinical gaps affecting our patients, so there’s no one better suited to seek out the answers of how to bridge those gaps. Our commitment to innovation has always been a collaborative one, encouraging the belief that the next great discovery could come from anyone.

Throughout my tenure as CEO Boston Children’s President (and incoming CEO) Sandra Fenwick and I have made it our mission to support programs foster innovation. Our Technology and Innovation Development Office helps innovators translate their research into new products that can benefit our patients and the public. Our Innovation Acceleration Program supports our grassroots innovation culture and community by providing employees with a variety of resources.

Through programs like these—as well as our collaborative partnerships in academia and industry—we are able to bring breakthroughs from the bench to the bedside faster than ever before. We are able to take an ever-increasing number of ideas that could help someone someday, and turn them into tangible treatments and products that are helping patients right now.

Having served Boston Children’s as its CEO since 2000, and as a practicing pediatric urologist for nearly 35 years, it has been my great privilege to witness our unswerving commitment to science, research and clinical innovation grow and flourish. In my retirement, I will take great pleasure in seeing what new frontiers Boston Children’s crosses next. I would like to thank each and every one of you for joining us in that journey, as we search together for solutions to some of the toughest challenges in pediatrics.

Thank you for joining us in Taking on Tomorrow.

James Mandell, MD
Boston Children’s Hospital

Building a whole heart for children born with only half.
Injectable oxygen microparticles that can save precious time in responding to cardiac arrest and brain injury.
An online platform allowing clinicians to share their expertise with colleagues across the globe.
Although autism can respond well to early behavioral interventions, it’s typically not diagnosed until around age 5. Boston Children’s researchers have taken steps toward developing early tests that could diagnose autism before symptoms even show up. Electroencephalograms (EEGs) are inexpensive tests that could potentially be harnessed to diagnose autism based on differences in brain activity and connectivity. In a study of 65 infant siblings of children with autism (considered to be at increased risk for autism themselves), Charles Nelson, PhD, director of the Labs for Cognitive Neuroscience, found a signature pattern in EEG waves from the frontal regions of their brains. These patterns were evident as early as 6 months and appeared even in high-risk infants who didn’t actually develop autism—suggesting they were born with a predisposition. In a separate study, Nelson and William Bosl, PhD, combined EEGs with machine-learning algorithms. The test had 80 percent accuracy in distinguishing between 9-month-old infants known to be at high risk for autism and controls of the same age.

Other investigators are analyzing EEGs for a quality known as “coherence”—a measure of connectivity between different brain regions. Frank Duffy, MD, led a study of 430 children with “classic” autism and 554 neurotypical controls, looking at more than 4,000 different combinations of electrode signals. The team identified 33 coherence readings that consistently distinguished the children with autism from the controls, with a sensitivity upwards of 90 percent. Using another algorithm, Duffy was able to distinguish children with classic autism from those with Asperger’s syndrome. Jurriaan Peters, MD, also looked at EEG coherence in two groups of autistic children: 16 with classic autism and 14 whose autism is part of a genetic syndrome known as tuberous sclerosis complex. Compared with controls, both groups showed multiple redundant connections between adjacent brain areas, but fewer linking far-flung areas.

“We could eventually come to the point where diagnostic differences are defined directly by differences in brain activity.”

Frank Duffy, MD

Autism detection advances through EEGs

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A better IV nutrition solution for infants

Many children recovering from complex intestinal surgery or awaiting intestinal transplants are placed on intravenous feeding, called parenteral nutrition (PN), until their intestines can digest solid foods. PN has revolutionized treatment for diseases such as short bowel syndrome, but unfortunately, its prolonged use often damages the liver, potentially leading to liver failure and the need for a liver transplant.

Over a decade ago, surgeon Mark Puder, MD, surgical resident Jenna Garza, MD, and pharmacist Kathy Gura, PharmD, discovered why PN was causing liver disease. Given to mice, the soy-based lipid used in standard PN solutions was causing fat to accumulate in the liver. They then tested Omegaven—aω-3-fatty-acid rich mixture made from fish oil—and found that the mice were completely free of liver injury. They went on to try Omegaven in some of their patients and saw their liver disease reverse.

Puder and colleagues now are conducting a formal clinical trial, funded by the March of Dimes and the FDA Orphan Products Division, aimed at preventing liver disease in children receiving PN.

To date, more than 150 children at Boston Children’s have received Omegaven, and more than 90 percent of them are still alive. In early 2013, Puder reported that of 48 infants given Omegaven, 71 percent had normalized liver function measures—and no longer needed a transplant.

Researchers rise to the CLARITY Challenge

Whole-genome sequencing has begun moving into the clinic, sleuthing out problems, offering hope for treatments that are more effective and more personal.

Globally, however, guidelines for appropriate, clinically useful genomic sequencing are just beginning to coalesce. To begin to advance such standards, Boston Children’s took a crowd-sourcing approach, launching the first CLARITY Challenge in 2012. The challenge tasked research groups from around the world with interpreting the genomes of three families with unexplained genetic diseases. The competition drew 23 teams, from 10 countries, and the results represent a clear victory not only for genomic medicine, but for patients everywhere.

For sixth-grader Adam Foye, who suffers from a muscle-weakening condition called centronuclear myopathy, CLARITY solved an 11-year mystery. Eight of the 23 contestants identified alterations in titin—a gene that encodes part of the contractile structure in muscles. Boston Children’s researchers plan to model the titin mutation in zebrafish and test panels of drugs that might reverse it—and perhaps help children like Adam regain their muscle strength.

Guidelines for interpreting genomic data and returning results to patients are being distilled to practitioners around the world. The CLARITY 2 Challenge, involving interpretation of cancer genomes, will be announced in 2014.
Building a whole heart for babies born with half

Children have enormous growth and healing potential. In late 2012, members of Boston Children’s departments of Cardiac Surgery and Cardiology—including Sitaram Emani, MD, Wayne Tworetzky, MD, James Lock, MD, and Pedro del Nido, MD—published a new strategy called staged left ventricle recruitment (SLVr) for rebuilding the hearts of children born with hypoplastic left heart syndrome (HLHS), a lethal heart defect where the main pumping chamber of the heart does not grow normally. All children born with HLHS currently undergo a set of three surgical procedures in the days, months and first few years after birth.

“The more blood flow we can direct into the left ventricle, the more it will grow, expand and pump in response.”

Sitaram M. Emani, MD

These three procedures help stabilize the heart and reconstruct it so that it can pump blood with only one ventricle. More than a decade in the making, SLVr harnesses the heart’s natural regenerative potential to encourage the undeveloped left ventricle of children with HLHS to grow—giving the child a fully functional heart with additional surgeries. The approach begins in utero and relies on a combination of surgical procedures developed at Boston Children’s over the past 11 years. The physicians are now seeking to refine the approach for children with closed or atretic valves.

Possibility in pediatric hand transplants

Hand transplants are a relatively recent medical advance in adults, and most are still being done under research protocols to determine their safety and efficacy over the long term. Slightly more than 50 have been performed in adults, and as of fall 2013, no transplants have been performed from a donor to a genetically different child. (One twin-to-twin transplant has been performed.) Boston Children’s experience with solid organ transplants, hand surgery and rehabilitation, along with its research capabilities, optimally position it to offer this experimental procedure to children. The Hand Transplant Program, kicked off in spring 2013, is currently enrolling transplant candidates over the age of 10, in good overall health, who for one or more years have been missing both hands. In addition, children who are missing one hand but are already on immunosuppression medication for a functioning solid organ transplant, or missing one hand and the other hand is poorly functioning, also will be considered.

The procedures will be conducted under a research protocol that will evaluate their safety and efficacy. Data on transplanted patients will be collected to measure the outcomes of the procedure and the patients’ progress over 10 years or longer.

EAT procedure allows patients to eat normally

The Esophageal Atresia Treatment (EAT) Program at Boston Children’s treats infants, children and young adults with esophageal and airway problems. And it is now home to one of only two hospitals in the world to offer a surgical innovation known as the Foker process to treat ‘long-gap’ esophageal atresia, a congenital condition where the esophagus has a disconnection or gap that interrupts its pathway to the stomach, making oral feeding impossible.

Developed by John Foker, MD, PhD, a pediatric, general and cardiac surgeon, the EAT procedure involves placing traction sutures in each of the two ends of the esophagus and increasing tension on the sutures daily, pulling on them slightly until the ends of the esophagus grow close enough to be sewn together to create a continuous connection between the throat and the stomach.
Little Fish, Large Impact

Zebrafish are fast-breeding freshwater fish whose status has quickly risen from fish tank mainstay to essential tool for genetic and pharmaceutical research in diverse medical fields.

The transparent embryos of zebrafish provide a literal window into how potential drugs may work. In 2007, researchers, led by Leonard Zon, MD, screened 2,500 chemicals in the hunt for drugs that could expand hematopoietic stem cells donated for transplant. The screen revealed that a drug called FT1050—a chemical derivative of a fatty, hormone-like molecule called prostaglandin E2 that was originally developed to treat stomach ulcers—could boost hematopoietic stem cell numbers by about four-fold.

In early 2012, FT1050 crossed a major milestone: the successful conclusion of a Phase I clinical trial. The trial’s findings established the drug’s safety as a way of helping patients who receive umbilical-cord blood stem cell transplants recover their immune function more quickly.

“As a physician-scientist, it is a dream to translate your basic science into a new therapy for patients. This is first time that a drug discovered using the zebrafish system has moved to a clinical trial.”

Leonard Zon, MD

Zon also has employed zebrafish in his search for potential treatments for melanoma, finding both a new melanoma-causing gene, SETDB1, and a potential regimen through an arthritis drug already on the market.

Also in 2011, Louis Kunkel, PhD, discoverer of the dystrophin gene that underlies the biology of Duchenne muscular dystrophy (DMD), found that aminophylline, an asthma medication, could help restore muscle in a zebrafish model of the disease. This discovery sparked a collaboration between Boston Children’s and Pfizer’s research unit, called the Centers for Therapeutic Innovation (CTI), to support Kunkel’s work. Through the CTI, he and his team were granted access to proprietary Pfizer compounds that they’re now screening in a zebrafish model for DMD, in search of any that might help rebuild muscle tissue.
Urinary tests for brain tumor recurrence

A urine sample can tell you many things. It can reveal pregnancy, signal an infection or unmask drug use. Could it also tell you about brain tumors?

In his Boston Children’s laboratory, neurosurgeon Edward Smith, MD, is finding that it can. Under the tutelage of his mentor, Marsha Moses, PhD, his sights are on biomarkers—proteins whose presence may signal new or recurring brain disease—that could diagnose and assess a brain tumor’s status in order to improve the ways he can monitor his patients postoperatively.

Current image-based screening for brain tumors and other neurologic diseases is time-consuming, costly and poses some risks. Smith does not intend to replace imaging studies, but wants to use urinary biomarkers to help decide whether a brain scan is necessary and gain additional information. "Someday, we could have people pee in a cup, drop it in a mailing box and, hopefully, find out if their tumor has come back without us having to operate on them," Smith says.

He plans to follow patients with brain tumors for at least two to three years, from initial diagnosis well into recovery, correlating levels of specific biomarkers with findings on brain scans. He is currently testing his approach in conjunction with a larger treatment trial for diffuse intrinsic pontine glioma, a highly lethal brainstem tumor. One major question will be whether the biomarkers identify tumor resurgence earlier, later or at the same time as the brain scans.

Another will be whether biomarkers can distinguish among different types of brain tumors and, ultimately, highlight molecular targets for destroying the tumor altogether.

Mounting a lasting local blockade against pain

Two years ago, Boston Children’s anesthesiologist Charles Berde, MD, PhD, led a quest to turn neosaxitoxin—a site 1 sodium channel blocker derived from ocean algae native to Chile—into a long-lasting local anesthetic for post-operative pain control.

The effort now has taken a big leap forward. Berde and his Chilean collaborators have launched a clinical trial in healthy patients, aimed at showing that neosaxitoxin—produced by biotechnology company Proteus SA from bioreactor-grown algae—is safe at clinically relevant doses and measuring how neosaxitoxin clears from the body.

The new trial will augment studies already conducted in Chile showing that neosaxitoxin can help patients undergoing laparoscopic surgery recover more quickly and experience less pain than patients treated with a local anesthetic, called bupivacaine.
Telemedicine brings expert blindness screenings to preemies

The more premature the baby, the greater the risk for retinopathy of prematurity (ROP), a major cause of blindness. ROP screening is required for babies born at or before 30 weeks gestation or weighing 3.3 lbs. or less. If caught early enough, ROP can be treated with laser therapy or medication.

Due to a regional shortage of available ophthalmologists, hospitals around Massachusetts often ask Boston Children’s specialists to perform these screenings. But this poses a problem: Even for nearby South Shore Hospital, the screenings took the Boston ophthalmologists half a day, allowing for travel time and waiting while the babies were prepped.

A telemedicine program is solving this problem. Tele-ROP began with work ophthalmologist Carolyn Wu, MD, did as a fellow nearly a decade ago with Deborah VanderVeen, MD. She tested a digital camera that takes a direct image of the retina in 43 infants and found it compared well with manual exams, missing no instances of treatable disease.

“Tele-ROP also is less uncomfortable for the babies and creates a lasting visual record. The manual exam used to require doctors to look directly into the baby’s retina through the pupil, using a speculum to open the eye and a probe to move the eye around and drawing pictures of the retina by hand. Now, nurses in the neonatal intensive care unit can take digital pictures that ophthalmologists can call up on their computer screens or even smartphones. The collaboration also represents a new business model for both hospitals. Health insurers reimburse South Shore Hospital in Weymouth, Mass., for the screenings, and South Shore, in turn, pays Boston Children’s Ophthalmology Department under a separate contract. This reimbursement model could be replicated with other hospitals in Boston Children’s network.”

Chief Innovation Officer Naomi Fried, PhD
Clinicians struggle to incorporate guidelines into their daily practices, resulting in disparity in care and costs. A quality improvement platform, developed by cardiologist James Lock, MD, and the Cardiovascular Program at Boston Children’s, is helping health care providers continuously improve their clinical practices, curb costs and improve patient care—by not just allowing but encouraging them to diverge from clinical guidelines.

The platform, called Standardized Clinical Assessment and Management Plans (SCAMPs) and supported by a consortium of Massachusetts payers, collects and analyzes clinical decisions data to standardize care in a fast-evolving clinical environment, providing a structured, eight-step approach to innovation that can be applied to nearly any type of medical problem.

SCAMPS help standardize care and reduce costs

For doctors and nurses in an intensive care unit (ICU), information overload isn’t just a daily reality—it’s a necessary one. To make the right decisions at the right time for each patient, they must keep tabs on numerous bedside monitors—in the ICUs at Boston Children’s, sometimes 10 or more monitors per child.

Cardiologist Melvin C. Almodovar, MD, and his colleagues wanted a better way to synthesize all that information quickly and catch crises before they happen. Working with software developer Arcadia Solutions, they built a web-based, portable early warning system called “T3” (for Tracking, Trajectory and Triggering).

T3 doesn’t cut down the amount of information. Instead, it streamlines and manages it, linking data from the child’s monitors and presenting readouts together, in context, on the same screen—matching the way critical care practitioners think. Introduced last year in Boston Children’s Cardiac ICU and Medical/Surgical ICU, Almodovar believes T3 could have a major impact on how decisions are made and how ICU care is provided.

Cardiologist Peter Laussen, MBBS, who worked to develop T3 with Almodovar, notes that, currently, doctors and nurses synthesize data on the fly, based on their experience and training, medical guidelines and what they see on a child’s monitors. The T3 system, which soon launches at Toronto’s Hospital for Sick Children and is being considered by other children’s hospitals, channels the flood of data by tracking and capturing all of the information from a patient’s numerous monitors, calculating trends in the data and showing a patient’s real-time trajectory and indicating if the patient is responding to care as he or she should.

Boston Children’s wanted to improve the experience of genomic sequencing and molecular diagnostics, pairing advanced instrumentation, software and bioinformatics capabilities with sophisticated clinical interpretation of test results, tapping the expertise of its specialist physicians and medical genomics experts.

Earlier this year, Boston Children’s partnered with Life Technologies Corporation to launch Claritas Genomics. The new company, majority-owned by the hospital and led by CEO Patrice Milos, Phd, has brought on board the hospital’s Genetic Diagnostic Lab. The CLIA-certified lab offers more than 100 genetic tests, many of which were developed at Boston Children’s. Claritas also will develop scalable genetic and genomics-based tests and provide genomic diagnostic services, including clinical and research genome and exome sequencing.

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Boston Children’s and Life Technologies form Claritas Genomics

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Episodes, a local bacterial infection of the bloodstream, triggers a runaway immune response that often severely damages the body it’s trying to save. Sepsis can result in shock, multiple organ failure and—for 210,000 to 375,000 people annually in the United States—in death. One group at particularly high risk for sepsis is babies in the neonatal intensive care unit (NICU). Hooked up to a number of catheters and intravenous (IV) lines, they are highly vulnerable to sepsis, and the infection can be hard to detect in these newborns.

A mouse model developed by infectious disease specialists Ofer Levy, MD, PhD, and Kenny Kronforst, MD, MPH, captures the effects of sepsis on newborns’ immune systems. The model has allowed the team to simulate what happens when an IV or catheter infection occurs in premature infants and to identify diagnostic markers to assess better treatments. If successful, the model could change the standard of care for premature babies and offer improved protection for these vulnerable infants.

Once sepsis is diagnosed, however, how do you treat it? Antibiotics can kill the bacteria, but they still leave bacterial debris in the bloodstream, fueling the already over-excited immune response. Removing the bacteria altogether would be the better solution.

The Laboratory for Biomaterials and Drug Delivery at Boston Children’s, run by Daniel Kohane, MD, PhD, has developed a new filtration approach that combines magnetic nanoparticles, a synthetic molecule called bis-Zn-DPA that binds to the bacteria and magnetized microfluidic devices to pull bacteria from the blood quickly and efficiently.

In Kohane’s vision, microfluidic devices would be incorporated into heart-lung machines, which in intensive care units are often used to circulate and oxygenate the blood of severely ill patients. Plasmapheresis or dialysis would also be candidates for this process.

Bubbling to the top

Patients unable to breathe because of acute lung failure or an obstructed airway need another way to get oxygen to their blood—and fast—to avoid cardiac arrest and brain injury. Now, through the work of Boston Children’s researchers, the idea of bypassing the lungs and injecting oxygen into the blood directly is becoming a feasible strategy.

Normally, injecting oxygen intravenously raises a risk of lethal gas emboli. But the team, led by critical care cardiologist John Kheir, MD, unveiled a major delivery innovation—tiny, gas-filled, injectable microparticles that can quickly and safely oxygenate the blood.

Kheir reports that an infusion of these microparticles into animals with low blood oxygen levels restored oxygen saturation to near-normal levels within mere seconds. The microparticle solutions are portable and could stabilize patients in emergency situations, buying time for paramedics, emergency clinicians or intensive care clinicians to more safely place a breathing tube or perform other life-saving therapies.

Unlike blood substitutes, which must be oxygenated by the lungs, the microparticles are designed for situations in which the lungs are incapacitated. Scientific American named oxygen microparticles one of their “World Changing Ideas” for 2012—an honor reserved for proven or piloted breakthroughs with the “potential to make what may now seem impossible possible.”

Better ways to combat sepsis

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Currently, there are two alternatives for fixing children’s hearts. One is open-heart surgery which involves opening the chest, stopping the heart, placing the infant or child on cardiopulmonary bypass, cutting into the heart and making the surgical repair. But there’s risk: it’s an invasive operation that may pose a risk of heart rhythm disruption, infection and complications related to the heart-lung machine. Recovery can take weeks or months.

The other option is a catheter-based intervention. Catheters, flexible, noodle-like devices, are not designed to perform maneuvers that require the application of force in multiple directions—like piercing and pulling tissue, connecting tissues together or removing abnormal tissue. It is these kinds of maneuvers that cardiac surgeon Pedro del Nido, MD, wants to be able to perform—without stopping the child’s heart.

A new robotic device, coupled with 3D echocardiographic imaging and a set of tiny tools, may be the solution—allowing precise manipulation of tools in tight spaces, on delicate tissues, during beating-heart surgery. The Boston Children’s team, including hospital engineers and outside partners, has developed and tested miniaturized, robotically controlled tools to close holes, shave off tissue and more, some of them now being tested in animal models.

The robotic system has many potential applications beyond the heart, including a version that could enter the brain through a small corridor to access deep-seated tumors and lesions.

Using digital photography to diagnose plagiocephaly

As a side effect of the successful Back to Sleep campaign to prevent sudden infant death syndrome, infants today spend so much time on their backs that their skulls sometimes flatten, causing an asymmetrical head shape known as plagiocephaly. Neurosurgeon Joseph Madsen, MD, wondered whether home-based digital photography could diagnose plagiocephaly and preclude an unnecessary trip to a specialist. In a pilot study, funded by the Innovation Acceleration Program at Boston Children’s, he asked the families of 35 patients examined in his Plagiocephaly Clinic to take top-down (vertex view) photos of their babies’ heads—including a ruler or other object in the picture for size perspective—and upload the photos to the web.

Two neurosurgeons, a nurse practitioner and a representative of an orthotics company, which develops corrective helmets, assessed each photo and estimated the head measurements that would determine whether a helmet should be considered. Their conclusions closely matched the diagnostic measurements taken in the neurosurgery clinic. The project is now being transitioned to community doctors’ offices, providing pediatricians with quick and easy access to online consults.

Tiny tools for beating heart surgery

PROBLEM-SOLVING DEVICES
LEVERAGING TECHNOLOGY TO IMPROVE CARE
Through partnering with biotech, pharmaceutical and medical device companies and investors, the Technology and Innovation Development Office (TIDO) works to translate research at Boston Children’s into new therapies, diagnostics and devices that can benefit the public.

Led by Erik Halvorsen, PhD, the TIDO team—with its experience in biomedical research, technology licensing, startups, business, marketing and law—uses a multi-faceted approach to support innovations through protecting and licensing intellectual property. Now in its fifth year, TIDO’s Technology Development Fund supports innovators’ projects and establishes research and development partnerships with the life science industry throughout the innovation to product life cycle.

Technology shows potential for novel research platform

Boston Children’s licensed a modified RNA technology, named one of TIME magazine’s “Top 10 Medical Breakthroughs for 2010,” to Moderna Therapeutics Inc. of Cambridge, Mass. The technology uses chemically modified RNAs to reprogram cells to serve as other cell types, and can reprogram various adult cells into pluripotent stem cells. It establishes a broad platform for producing novel research tools as well as developing therapeutics in regenerative medicine. In March 2013, Moderna signed a five-year, $240 million strategic agreement with AstraZeneca to discover and develop messenger RNA therapeutics.

Earlier detection of autism

SynapDx Corp. licensed worldwide rights to Boston Children’s discoveries to accelerate the development of its blood-based tests to enable the early detection of autism spectrum disorders. Boston Children’s test, a panel that measures the activity of dozens of genes at once, was able to predict the presence of autism in children as young as 2-years-old with about 70 percent accuracy. SnapDx hopes to provide a laboratory-testing service to physicians who evaluate children for developmental disorders, with the goal of enabling earlier detection of autism. In July 2013, SynapDx secured $15.4M in funding led by Google Ventures.

Shire and Boston Children’s enter into rare disease collaboration

To best leverage Boston Children’s research expertise and the development and commercialization capabilities of Shire plc, in 2012 the two organizations entered a three-year research collaboration in rare diseases. The goal of the collaboration is to develop novel therapies to treat rare pediatric diseases with high unmet medical need.

Collaboration to screen and identify treatments for autism

Boston Children’s, Harvard Medical School and the Harvard Stem Cell Institute have formed a collaboration with Roche to generate patient-derived functional neurons, and use these cells to screen and identify new drugs for the treatment of autism spectrum disorders.

Scanner shows promise for early detection of “lazy eye”

REBUScan has exclusively licensed the Pediatric Vision Scanner, an easy-to-use device developed in Boston Children’s Department of Ophthalmology, for early detection of amblyopia ("lazy eye"). If amblyopia is caught early—ideally, before age 3—it can easily be treated, but if it goes unnoticed, the weak eye can slowly go blind. The Pediatric Vision Scanner was developed with help from Boston Children’s Technology Development Fund.

IAP Innovation Acceleration Program

Since its launch in 2010, the Innovation Acceleration Program (IAP) has been a mentor and guide to innovators both novice and seasoned at Boston Children’s. Led by Chief Innovation Officer Naomi Fried, PhD, the IAP takes a three-pronged approach to fostering the hospital’s innovation culture:

- identifying, catalyzing and supporting new opportunities for innovation
- promoting and facilitating grassroots innovation
- collaborating on and supporting strategic initiatives at the institutional level

Over the past three years, the IAP has established a range of programs designed to remove barriers to innovation, educate hospital staff and employees about the innovation process and nurture a culture that encourages and supports new ideas from across Boston Children’s.

Innovators’ Forums have been held to facilitate the exchange of ideas and connect innovators with one another and with helpful resources.

Clinical and non-clinical divisions have been represented in Innovation Boot Camps—educational workshops designed to teach participants about the innovation process and lower the barriers to developing a new idea.

“Investment grants” awarded by IAP to innovators from more than nine hospital divisions. Funds are used to conduct feasibility studies, develop models or prototypes, collect data and test solutions. In addition to funds, the IAP helps winners to navigate obstacles, connect with potential collaborators and pursue patenting and licensing opportunities with the Technology and Innovation Development Office.

Telehealth pilot programs have been launched.

Individual consultations have taken place through Innovation Clinics and personalized consulting advice to individual innovators or innovation teams for particular projects.

In-person and virtual attendees participated in an innovation day that showcased clinical products, processes and technologies that are making health care safer, better and less expensive.

“Fasttrack Innovation in Technology (FIT) Awards have been given” to technology innovators at Boston Children’s to develop clinical software solutions that integrate with clinical systems to support clinicians and patient care. FIT awardees get time with a dedicated, experienced development team that builds out the novel solutions with them.

Since its launch in 2010, the Innovation Acceleration Program (IAP) has been a mentor and guide to innovators both novice and seasoned at Boston Children’s. Led by Chief Innovation Officer Naomi Fried, PhD, the IAP takes a three-pronged approach to fostering the hospital’s innovation culture:

- identifying, catalyzing and supporting new opportunities for innovation
- promoting and facilitating grassroots innovation
- collaborating on and supporting strategic initiatives at the institutional level

Over the past three years, the IAP has established a range of programs designed to remove barriers to innovation, educate hospital staff and employees about the innovation process and nurture a culture that encourages and supports new ideas from across Boston Children’s.

Innovators’ Forums have been held to facilitate the exchange of ideas and connect innovators with one another and with helpful resources.

Clinical and non-clinical divisions have been represented in Innovation Boot Camps—educational workshops designed to teach participants about the innovation process and lower the barriers to developing a new idea.

“Investment grants” awarded by IAP to innovators from more than nine hospital divisions. Funds are used to conduct feasibility studies, develop models or prototypes, collect data and test solutions. In addition to funds, the IAP helps winners to navigate obstacles, connect with potential collaborators and pursue patenting and licensing opportunities with the Technology and Innovation Development Office.

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Telemedicine and medical apps are altering the nature of medical encounters. They're connecting providers in different locations, improving patient-provider communication and empowering patients through better access to information. Among Boston Children’s technology-based projects underway are:

**Concussion follow-up by videoconference**

Multiple follow-up appointments after concussion are necessary to assess brain functioning, but can be difficult for families to manage. Karameh Hawash, MD, and colleagues at the Brain Injury Center at Boston Children’s are piloting a telehealth program that offers videoconferencing-based cognitive assessment, a great convenience for patients living far from the hospital.

**Teledermatology as a “shared-care” model**

Many patients referred to the dermatology clinic at Boston Children’s have common skin conditions that could be managed by their primary care physician with targeted decision support from a dermatologist. Laura Johnson, MD, MPH, partnered with dermatologist Stephen Gellis, MD, and the Innovation Acceleration Program (IAP) to launch a pilot teledermatology program. In this pilot, staff at Martha Eliot Health Center, a satellite of Boston Children’s, photograph the rash and securely transmit the images along with an online form to the dermatologist, who reviews the data and responds with recommendations.

**Using gaming to help prevent transplant rejection:**

An organ transplant is just the beginning. Recipients need to adopt strict medication routines and behavior changes to avoid losing the transplanted organ, and this is hard, particularly for teenagers. Tapping teenagers’ love of online games, Boston Children’s “Teens Take Charge” helps prepare them for life after an organ transplant by identifying and helping them overcome their personal barriers to adherence. Through a leaderboard, patients can track their game scores against those of other transplant patients.

**Could text messaging reduce hospital readmissions?**

Proactive, automated communication with patients post-discharge—via text messaging—is highly feasible and might avert costly readmissions. Supported by the IAP’s FastTrack Innovation in Technology (FIT) team, Vincent Chiang, MD, an emergency medicine physician, recently piloted the DisCo (Discharge Communication) project in an inpatient unit. Of 100 families approached, 82 agreed to being messaged three yes/no questions after discharge. Forty-four patients responded to all three questions. A “yes” response to any question triggered a phone call from the nurse practitioner. The pilot was well received by patients and saved nurses’ time in helping to pinpoint which patients required follow up.

**Streamlining emergency care**

Debra Weiner, MD, PhD, saw a way to save time in the Emergency Department (ED) and avoid unnecessary waiting. Using a FIT award and working with the FIT development team, she built BEAPPER, an iPhone app that sends real-time, Twitter-like alerts to ED staff when beds become available, orders have been placed and lab results are back. Further reducing delays, physicians can quickly check on their patients’ status without having to log onto a computer.

**The fine art of interpreting a child’s blood pressure**

Measuring blood pressure (BP) is recommended for children 3 years and older. However, interpreting BP measurements for children is complicated by the need to account for a constantly changing body size, requiring doctors to consult a very complicated chart to determine their BP percentile. Working with SMART, a government-funded project that aims to create modular, iPhone-like health apps, Justin Zachariah, MD, MPH, of Boston Children’s Preventive Cardiology Clinic, created Blood Pressure Centiles. The app, now rolling out across the hospital, automatically integrates contextual information from the patient’s chart—age, sex, height—to help clinicians interpret the readings and graph them over time. Since the app is designed to work with a number of electronic clinical systems, it is readily adaptable by other children’s hospitals.
**Infectious disease, global vaccine**

Around the world, *Streptococcus pneumoniae* (also known as *pneumococcus*) is responsible for the deaths of more than 1 million children a year. The dedicated efforts of Richard Malley, MD, and collaborators, Ying-jie Lu, PhD, and Porter Anderson, PhD, have resulted in a vaccine that could potentially eradicate this disease in newborns.

The challenges in creating a vaccine with widespread, global applications are numerous. The greatest obstacle is producing a vaccine in the necessary quantity, at an affordable cost. Further, the current 7- and 13-valent vaccines in use are not only expensive, but do not protect against all the strains of pneumococcus.

After extensive research and testing, Malley and his team identified an approach where different components of pneumococcus are combined. The resulting mixture can be effectively injected as one vaccine, which provides antibody-mediated and T-cell-mediated protection against all forms of pneumococcus, not just specific strains.

The new approach, called the Multiple Antigen Presenting System, also is readily adaptable for use against other pathogens, making it a “vaccine platform” with broader potential applications.

**Sharing knowledge across the globe**

Nearly 10 million children under the age of 5 die every year, even though existing medical and surgical options might be available to save them. In a world of medical specialists, a stark inequity of knowledge distribution and information exchange still persists, which is exacerbated by educational obstacles.

Boston Children’s critical care specialists, Jeffrey Burns, MD, MPH, and Traci Wolbrink, MD, MPH, believe that part of the solution is developing an interactive application dedicated to removing the bottlenecks of information.

Their answer is OPENPediatrics™, an education platform, designed in collaboration with IBM, that provides clinicians across the globe with access to colleagues and vital information when it’s needed. The peer-reviewed, open-source and nonprofit application coalesces, leverages and scales the accrued wisdom of international providers into one accessible place.

“Nothing breaks down walls and brings people together like caring for a critically ill child.”

Jeffrey Burns, MD, MPH

One way it does this is through “staged learning,” in which clinicians are guided through curricula, including pre- and post-tests, video lectures and printable summaries with associated tools and simulators. Users can access videos on the care of critically ill children, operate tools (including medical calculators and drug dosing aids) and train on a mechanical ventilator simulator. The platform also includes a social network capability for knowledge exchange.

In addition to helping caregivers increase their skills and confidence for pediatric emergencies, it creates a forum to foster interaction among the global community of practitioners. For example, OPENPediatrics’ World Shared Practices Forum harnesses the knowledge of physicians and nurses from Bangladesh on the management of diarrheal diseases such as cholera, from South Asia on the management of malaria, from North America on proven and efficient measures of infection control and more.

In late 2012, Boston Children’s and IBM launched the beta version of OPENPediatrics with 1,000 clinicians in more than 40 countries, across six continents. A cloud-based version 1.0 is anticipated in late 2013.
Shining light on jaundice in the developing world

About 8 percent of all newborns are affected by jaundice severe enough to need treatment. If left untreated, the characteristic yellow pigment that causes jaundice, called bilirubin, can accumulate in the brain and cause permanent brain damage or death.

In the developed world, the treatment of most newborns that develop jaundice is simple: phototherapy with lights tuned to a particular wavelength of blue. But the developing world is quite different. Sometimes the nearest hospital with phototherapy equipment is hours or days away. And even though it’s simple, phototherapy requires reliable electrical power.

In regions with few resources, the best solution should be small and portable, run on batteries or other off-grid power sources, cost little, but still be safe and deliver the right wavelength and intensity of light. Enter attending neonatologist Donna Brezinski, MD, and her invention, called the Bili-Hut.

The Bili-Hut is a battery-powered pop-up tent lined with LEDs. Collapsible and highly portable—it can fit into a shipping tube—it’s still big enough for a newborn to fit inside comfortably. The LED lights that line its inner surface are arranged in a radial array and can shine the right kind of blue light at the right intensity over a baby’s entire body. All the parts are off-the-shelf; the interior lining, for example, is made from a material used for hydroponic gardening. It can run off 12-volt power for one month but can also be plugged into a wall socket if grid power is available.

Brezinski has launched Little Sparrows Technologies to develop and commercialize the Bili-Hut and is attempting to raise funds and field test the system in India.

Boston Children’s Hospital Executive Leaders

Sandra Fenwick
President and CEO

Kevin Churchwell, MD,
Executive Vice President of Health Affairs and Chief Operating Officer

Dick Argys
Senior Vice President and Chief Administrative Officer

Margaret Coughlin
Senior Vice President and Chief Marketing and Communications Officer

Gary Fleisher, MD
Physician-in-Chief, Pediatrician in Chief, Chair of Department of Medicine

Naomi Fried, PhD
Chief Innovation Officer

Erik Halvorsen, PhD
Executive Director, Kathy Jenkins, MD
Senior Vice President and Chief Safety and Quality Officer

James Kasser, MD
Surgeon-in-Chief, Chief of Orthopedic Surgery Emeritus

Daniel Nigrin, MD, MS
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