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The day is already hot in Bangladesh’s Rajshahi Division. The muezzins have long since announced the dawn prayer, and the blue sky frustrates the villagers’ hopes for the monsoon rains. A farmer drives a pair of white oxen along a road that bisects fields of rice and jute. A shirtless man strains to pedal a rickshaw van. A woman in an orange sari hangs laundry on a rope strung between palm trees.

As farmers and housewives begin daily routines that have remained constant for generations, 652 local women are starting a day’s work that is novel for Bangladeshi villagers: collecting public health data. Setting out on foot and by bicycle, they are instrumental in conducting one of the world’s largest community trials of the role of nutrition in maternal and infant survival. By the trial’s conclusion in 2011, these JiVitA Project workers will have recruited nearly 100,000 pregnant women and their babies.

The decade-long JiVitA Project comprises three main studies that have shared a common purpose: testing whether micronutrients will save the lives of mothers and babies in northwestern Bangladesh—and by extension, in other rural regions of South Asia. JiVitA (pronounced “jee-veetuh”) is a play on the Bangla word jibheetoh, or “alive.”

“We see great opportunities for public health approaches to improve health and reduce infant mortality in these vast rural settings of South Asia,” says JiVitA Project investigator Parul Christian, DrPH ’96, MSc, MPH ’92, an associate professor of International Health at the Bloomberg School.

The project in Bangladesh grew out of a groundbreaking nutrition trial in Nepal that concluded in 1997. That trial, also led by School faculty, showed that giving vitamin A to pregnant women reduced maternal deaths by 44 percent overall. These remarkable results prompted researchers to wonder: Could vitamin A also improve survival in other parts of South Asia where malnutrition was widespread?

In the 11 years since the JiVitA Project started in Bangladesh, researchers have investigated the effect of vitamin A on maternal health (JiVitA-1) and infant health (JiVitA-2). The study now under way (JiVitA-3) is examining whether infants are more likely to survive if their mothers are given a daily multi-micronutrient supplement during pregnancy.

“We see great opportunities for public health approaches to improve health and reduce infant mortality in these vast rural settings of South Asia,” says JiVitA Project investigator Parul Christian, DrPH ’96, MSc, MPH ’92, an investigator for all three trials and an associate professor of International Health at the Bloomberg School.
on this July morning, in week 448 of the JiVitA Project, field distributor Nur Banu is visiting a new baby. This “JiVitA baby” was born the previous afternoon in the village of Kamar Pachgachi, where Banu herself lives.

As one of the 596 field distributors—all of them female—Banu is assigned to find local women as soon as they become pregnant, recruit them to the study and then give them prenatal supplements. In addition, whenever a child is born, the field distributor doses the new baby with vitamin A. That task brings Banu here today.

She finds the newborn asleep in the family’s kitchen shed, lying on a bed of rags and straw. The child’s mother, Shahinoor, sits on a low stool beside the chubby-cheeked baby girl. The baby is Shahinoor’s fourth child, and she is not yet named. Shahinoor looks frail, her red cotton sari draped over her head. Like 95 percent of JiVitA babies, this one was born at home. In keeping with village customs that regard childbirth as polluting, Shahinoor did not give birth in the family house, however. The combination kitchen shed and cow stall next to the house served as an *atagarh*, or labor room. The shed has grass walls, a mud floor and a corrugated iron roof. Mother and daughter will remain there for three days. On the third day, a barber or someone else chosen by the family will shave the baby’s hair, which is considered unclean. Then Shahinoor will return to her house, and her newborn daughter will enter it for the first time.

Banu greets the new mother and unpacks her supplies just inside the shed door. She has been here dozens of times. She began visiting JiVitA household #0049 even before Shahinoor became pregnant with this child; as a married woman of childbearing age, Shahinoor was a candidate for the study and has been among the local women Banu regularly visits in her search for pregnant women. In December, Shahinoor told Banu that she’d missed her period. Banu tested her urine to confirm the pregnancy and invited Shahinoor to take part in JiVitA-3. Like 98 percent of women asked to participate, Shahinoor consented. Since then Banu has visited Shahinoor twice a week to remind her to take the daily supplements, to record how often she has done so, and to refill her supply.

By the trial’s end, Banu and her co-workers will have followed 36,000 pregnant women to measure the effects of multiple micronutrients on infant mortality and morbidity.

Because the trial is blinded and randomized, Banu doesn’t know if the red tablets she gives Shahinoor contain the 15 nutrients or an iron and folic acid supplement that meets the WHO standard of care.

Today Banu is accompanied by two other women. One is interviewer Lovely Rani Mondol, who will ask Shahinoor about the
The other is researcher Parul Christian, who is visiting from Baltimore for two weeks. Christian has visited the JiVitA Project so many times that she's lost count, and by now her Bangla is pretty good. She can follow most of what goes on as she crouches in one corner of the atur ghar watching Banu at work.

Banu squats beside the newborn. She uses scissors to snip off the end of the vitamin A capsule, and she deftly squeezes the contents into the baby’s mouth. The baby grimaces, then cries and turns red. With this first taste of something other than milk, the child is benefiting from what researchers discovered in the JiVitA­2 study. In that trial, all JiVitA newborns were given either 50,000 IUs of vitamin A or a placebo. Led by assistant scientist Rolf Klemm, DrPH '02, MPH '85, field staff dosed 16,000 newborns. Klemm and colleagues reported the results in the July 2008 *Pediatrics*: A single two-cent dose of vitamin A cut six-month death rates by 15 percent. Now all JiVitA babies get vitamin A soon after birth.

Standing in the doorway of the house, the baby’s grandmother silently watches the scene. From her point of view, her son and his wife must seem fortunate, for they have never lost a child. Of the grandmother’s eight children, four died in infancy. She lost three boys and a girl.

On a conventional map, JiVitA territory stretches across the sector of northwestern Bangladesh called Gaibandha District and nips into Rangpur District. To the research team, this is “Jivitaland.”

Jivitaland requires its own map. No ordinary map would show Shahinoor’s house in Kamar Pachgachi. The red number 0049 painted on the corrugated iron near the front door signifies her home’s inclusion on an extraordinary digital map, one that records the location of every one of 145,000 households in the JiVitA study area. To create it, 64 survey teams walked the entire project territory—270 square miles. They validated and augmented information on 1930s-era paper maps drafted by the British during the colonial era. They assigned a number to each household, or *khana*, “those who eat rice from the same cooking pot.” Nine years later, fieldworkers carry bottles of red paint to touch up faded numbers.

At any given time, each field distributor is monitoring about 200 women of childbearing age. Each month, the distributors supply vitamins to about 8,000 pregnant women. And on an average day in Jivitaland, those women give birth to 29 babies.
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Christian and West hadn’t expected to do this research in Bangladesh, but rather in India, where Christian grew up. But in 1998, when they looked at governmental and NGO data for the Gaibandha area of Bangladesh, they found pervasive signs of malnutrition. Anemia rates for women of reproductive age were 46 percent. More than half the children were stunted. These signs suggested that rates of malnutrition were similar to those in other impoverished regions of rural South Asia.

Furthermore, recalls Christian, in Bangladesh “we found the right spirit of collaboration,” in particular with the Bangladesh Institute of Research for Promotion of Essential and Reproductive Health and Technologies. And it was through the director of that institute—West’s Hopkins classmate Halida Akhter, DrPH ’82, MPH ’79—that West met the physician who would become the first of their Bangladeshi research partners, Mahbubur Rashid, MBBS, PhD, MSc. As Rashid recalls, “Keith did a five-minute rapid assessment, and from then on I was with them, every minute—with no time for sleeping.” Rashid is now the project’s medical epidemiologist and a member of senior management.

That was in 2000. Soon after, the project hired a core staff of 80. They laid the groundwork for the project by convening community information sessions in rural villages and meeting with government leaders, journalists, school principals and clergy, both Muslim and Hindu.

Good community relationships would provide the foundation for this large study, but only good data would ensure its scientific value. Rashid jokes that West was so intent on

**JIVITA’S PIONEERING PATRIMONY**

The JiVitA Project’s patrimony is the pioneering Vitamin A research of Hopkins legend Alfred Sommer, MD, MHS ’73, Bloomberg School dean emeritus. Beginning in Indonesia in 1976, Sommer (right) and collaborators conducted large community studies in Asia proving that even a mild vitamin A deficiency reduces childhood resistance to disease and increases pediatric death rates. Other community- and hospital-based studies in Africa showed that giving vitamin A to children increases resistance to measles, diarrhea and other infectious diseases and could cut the deaths of children by 25 percent to 55 percent.

Keith West’s Nepal study grew out of those findings. From 1994 to 1997, the Hopkins research team, including Joanne Katz, ScD ’93, MS, and Christian, enlisted 20,000 pregnant women in southern Nepal to find out if vitamin A would reduce maternal deaths. The maternal mortality ratio there was 600/100,000 live births. (For comparison, in the U.S. the ratio per 100,000 births was 12, and in Canada, 6, based on WHO data for 1995.) The team gave each woman in the Nepal study either a placebo or one of two weekly vitamin capsules. One contained vitamin A and the other beta-carotene, a form of vitamin A found in vegetables and fruits. The results were dramatic: Vitamin A cut maternal deaths by 40 percent and beta-carotene by 49 percent. This was the first study to show that vitamin A could yield such marked reductions in maternal mortality.

Because rates of maternal mortality and malnutrition in Bangladesh were thought to be similar to those in Nepal, the next step was to set up a trial to test whether vitamin A could also save lives in Bangladesh. “That was an obvious one,” said West. He laughs, adding, “It didn’t work.” In Bangladesh, neither vitamin A nor beta-carotene reduced maternal deaths.

Why not? “By all indications,” says West, “health and nutrition of young mothers, and the minimal care available to them, began to improve around the turn of the last decade, when the JiVitA trial was getting under way.” Life in Bangladesh was changing rapidly. “We can point to roads that were barely passable in 2000 that are now paved. They bring access to a whole range of services and assets, including health care. It doesn’t have to be great health care to reduce maternal mortality.”

By the end of the first JiVitA trial in 2006, death rates were less than a third of what had been expected. As Christian explains, “If you have a very low baseline of mortality, then it is unlikely that the remaining causes of mortality can be influenced by an intervention such as vitamin A.”

While the results of the maternal vitamin A trial were disappointing, the success of the concurrent trial of vitamin A for infants suggests an inexpensive strategy for saving the lives of babies. The 15 percent decline in infant deaths in Jivitaland confirmed similar outcomes in trials in India and Indonesia. Pooled analysis of the three studies suggested that newborn vitamin A could reduce infant deaths in rural Asia by 20 percent.

Nutritionists aren’t sure of the exact mechanisms for the protective effect of vitamin A, but they do know that A is critical for newborn lung development and that it enhances immunity. Researchers predicted that in Bangladesh alone, if 70 percent of vulnerable infants got a single two-cent dose, vitamin A could avert the deaths of nearly 24,000 babies each year.

—CS
gathering consistent data that he would have liked a single person to do it all. As Rashid puts it, “Data collection should be as faithful as a photograph in creating a picture of public health.” And so training for field staff in 2001 was extensive: three months, full-time, for the 596 field distributors; and nine months, full-time, for 56 female interviewers who also do anthropometry (physical measurements) of mothers and infants. Christian told the trainees: “You need to treat data as representing real lives. The data are not just numbers, they’re telling us a story about the life of an individual.” Without an accurate depiction of those life stories, she told them, “You’re not going to get the right answers to the research questions.”

On this July morning, precision is Christian’s chief concern as she watches Banu and interviewer Mondol at work. By witnessing data collection, Christian says, “I can observe how accurately it’s being done and whether protocols are being followed.”

Being female provides latitude for Christian as a researcher. Women in South Asia are unlikely to discuss the intimate topic of reproductive health with men in the room, and following a birth, taboos require male researchers to keep their distance. “As a female, I have the advantage of being able to do some of the direct observation, which is not as possible for Keith and Alain,” says Christian, referring to West and assistant professor Alain Labrique, PhD ’07, MS, MHS ’99. Labrique, an expert on health and society in Bangladesh, served as the Hopkins Project Scientist in-country for seven years.

Mondol is kneeling beside the newborn, measuring her head, when the baby’s father arrives home for lunch. Rezaul Alam is barefoot, his cotton lungi (sarong) splattered with mud. Alam has spent the morning drying jute grown on the family’s quarter acre. He glances toward the kitchen shed, then escapes the glare of the sun as he enters the family’s one-room house. He sits on one of the two beds. Besides farming, Alam sells jute seeds, and the cotton bedcover is made of seed sacks sewn together.

Alam says that he and his wife had not planned for a fourth child, “but as Allah gave her to us…” He does not complete the sentence, but he looks content. He wraps his arm around the younger of his two sons, Mominul Islam, whom his father estimates to be “maybe 5 years old.” Alam thinks that he and his wife are about 25 years old. (Few village residents can confidently say how old they are. “How can we know our age?” asked one woman with amusement.)

Shahinoor and Alam’s oldest child honors the visitors by offering a tray of paan—chopped areca nuts, green betel leaves for wrapping around them, and powdered lime. At 11, Sajeda is young enough that she does not yet have to wear a sari or a complete salwar kameez (loose pants and a knee-length tunic worn with a long scarf). Instead she wears a yellow tunic over shorts, more comfortable on a day with temperatures in
the low 100s. Unlike her mother, who never learned to read, Sajeda goes to school. She is cheerful and confident, with a short haircut that accentuates her bright eyes. She tells her father: “We should name the baby Renu.” He nods but makes no promises.

The grandmother watches from the courtyard as Shahinoor cradles her newborn; the baby is peaceful again after the annoyance of swallowing vitamin A.

For Christian, a visit to Bangladesh means hours and hours in meetings.

On this sweltering afternoon, she sits under the ceiling fans in the conference room of the project’s four-story office building in the town of Gaibandha. A dozen senior staff members are discussing a JiVitA-3 sub-study that seeks to understand the movement of micronutrients from mother to fetus. To do this, six nurse-midwives will soon begin attending births, sampling umbilical cord blood and weighing placentas immediately after delivery. This afternoon’s scientific task is to agree on standardized conditions under which the midwives will refer mothers and newborns to emergency care. The administrative issue: how much to pay the midwives for 24-hour on-call duties. The group arrives at all decisions by consensus.

Between field visits and meetings, sometimes late at night, Christian confers.

WHEELS OF CHANGE

“Shorbanash! [the world is coming to an end!],” the old man cried as he watched Bloomberg School research associate Sucheta Mehra pass by on her bicycle. “If women start riding bikes, you won’t have children!”

JiVitA interviewer Rownok Jahan has heard similar warnings. Bicycling will damage your uterus, people told her. Staff coordinator Habib-ara was told, “It will interfere with finding a husband.”

Mehra, MSc, explains resistance to bike riding this way: In rural Bangladeshi society, women have traditionally remained largely inside their homes. Therefore, “a woman who is visible in the community in a culture of purdah is bold—the kind of woman the husband might not easily control.”

For nine years, the project’s 112 female interviewers and team leaders have all been bold enough to ride bikes. And two dozen women working as staff coordinators and managers have ridden motorcycles.

“Now it’s treated as an honor,” says Habib-ara, who uses a motorcycle as she oversees 60 field staff in several villages. “It’s a status indicator.”

The change in attitudes is a sign of the cultural impact of the decade-long JiVitA Project on the people of Rajshahi Division. The project is also changing the region’s socioeconomic landscape by providing women with salaried jobs where such jobs are scarce.

When the study was established, 2,300 women applied to fill 650 positions. Rashid describes those hired as “the cream of Gaibandha.”

“JiVitA is for women, by women,” says Rashid. Eighty-five percent of the 850 employees are women. Before the project, nearly all were housewives. “Now they are coming into offices, they are earning cash money,” says Rashid. “When someone works, dresses well and sends their children to good schools, they are respected in their communities.”

Rashid believes that these women have gained confidence to speak up more within families that are generally dominated by males and mothers-in-law. To find out if this is true, Mehra is analyzing data from a study comparing JiVitA women to other women. The study, established by Alain Labrique, nutritionist Abu Ahmed Shamim, MSc, and Keith West, began in 2001 with interviews of applicants for JiVitA field distributor positions. Four years later, researchers re-interviewed 570 women who got the jobs and 366 women who were not hired. The three-hour interviews incorporated what Mehra calls “empowerment proxy questions”—for example, whether the woman is permitted to go to the village market un-chaperoned; if she voted in the last election, and whether she chose whom to vote for; how much power she has in budgeting family income; what she spends on clothes for herself and for her children; who decides when to seek health care for a child; and who chooses whether to use contraception.

Along with a similar study by the Hopkins team in Nepal, Mehra says that this “is one of the very, very few studies that I know of where we have been able to track long-term employment of women and therefore had the capacity to look at women’s empowerment over the long term.”

Staff coordinator Habib-ara likes to think she serves as a role model for women in Jivitaland. “We may inspire them. They will give their children a proper education.” A dozen JiVitA mothers have honored her by naming their daughters Habib-ara. “They named their children after me with the expectation that their daughters will serve society and ride a motorcycle like me.”

—CS
with graduate students working on the project—three at the moment. To keep morale high, she’s brought them a box of Lindt chocolates. She says, “I feel that they’re being deprived when they’re just eating a dal-bhat meal [lentil gruel and rice]. They’re probably craving chocolate.” Good chocolate is scarce in Bangladesh, but there are compensations: During afternoon meetings, the head cook arrives in the conference room with plates of luscious local mangoes and cups of sweet tea.

The Gaibandha office building is home base for many of the project’s 180 scientific, supervisory, logistics and administrative staff. Among others, they include 15 people who enter data, six physicians, four translators, two cooks and a mechanic to look after the project’s 53 motorcycles.

The tremendous organizational feat that has made JiVitA possible could bear fruit in at least two ways. First, the project’s findings on infant vitamin A could lead to national policy: widely distributing vitamin A to newborns could cut infant deaths by 20 percent in Bangladesh and elsewhere in the region. Already, senior JiVitA researchers have spread the news about the effects of infant vitamin A at 15 presentations to Bangladeshi government officials and groups of doctors.

The next step is to figure out how to deliver the vitamin A to newborns beyond the study area. This poses huge logistical challenges. In rural areas, most babies are born at home and without a health care professional attending. A survey in the JiVitA Project area, for instance, found that only 8 percent of women gave birth attended by a nurse-midwife or doctor. Half the women had help only from relatives or neighbors, or they gave birth alone. Bangladesh’s Ministry of Health is close to granting permission to JiVitA to begin operations research into how to broadly distribute the vitamin to newborns, says Rashid.

The second legacy of JiVitA may be the research site itself, providing more opportunities for research in Jivitaland, home to 650,000 people. It’s unclear what might come next, but West, Christian and Labrique all have proposals in the works for further studies in maternal and child health.

Rashid feels confident that scientists will continue to come, whether from Hopkins or elsewhere. “The infrastructure is here,” he says, “so the cost would be minimal to continue research. We have a huge cohort of the population. We have detailed maps, GIS maps, of this population, and trained manpower—womanpower, human power. ... It’s a diamond mine. We just need some good research questions.”

Christian says, “Our biggest challenge is to continue to sustain the big population site that we have spent so much time and effort developing. Our Bangla staff feels a strong sense of ownership.”

In the village of Sahabaz, in one of the 145,000 households in Jivitaland, a baby boy sleeps aloft: his small bed is suspended from a bamboo rafter by jute ropes and decorated with colorful ribbons. Interviewer Ripu Rani has come to see the month-old child and his mother, Asiya. Rani will ask Asiya a series of standardized questions about her son’s first month of life and about Asiya’s own health during her final month of pregnancy and the month since the birth. This is one of six or seven interviews that Rani will do today, traveling by bicycle.

Asiya’s child continues to sleep as Rani unpacks bulky bags of equipment, including adult and infant scales and a board for measuring the length of infants, designed and built by the JiVitA Project. Rani first met Asiya a few days after a field distributor confirmed her pregnancy. At that first meeting, Rani asked Asiya baseline questions about her health, her diet, her work history and her socioeconomics status. She learned then that like many villagers, Asiya’s family owns no land. Her husband earns money as a farm laborer, and Asiya raises poultry: two chickens and four ducks.

Today, Rani weighs the baby, now awake and crying piteously, and she measures his upper arm, chest, head and length.

Sooner or later, field staff like Rani will inevitably face the death of a participant’s child. One of Rani’s colleagues, field distributor Selina, comforts the mother this way: “I try to make her understand that the baby came from Allah. It’s the will of God—that’s why the baby’s dead. Any of us can go at any time.”

Such painful conversations are rare for Selina. “I feel valued,” she says. “I hope JiVitA will continue to run. I can work with it, and I can survive.”

For physician and epidemiologist Rashid, working for JiVitA not only allows him to earn a living, but also to serve humanity. “I think this is the motivation for all of JiVitA,” he says. “Doing good for people in need and serving them is a sort of prayer.”

During her site visits, Parul Christian handles daunting scientific and administrative details.
COUNTING SLEEP

STORY BY DAVID TAYLOR / ILLUSTRATIONS BY DUNG HOANG
Our culture of 24/7 distractions and demands is sapping our sleep. As up to 70 million Americans report chronic sleep problems and fewer adults get sufficient pillow time, scientists are making new connections among dreams, disorders and disease.
A gift. Nature's soft nurse. A poor man's wealth. More strange, more beautiful … than the wings of swans …

For millennia, humanity turned first to poets to understand the mystery called sleep. In the Iliad and the Odyssey, Homer speaks of gods and warriors partaking of the gift of sleep. Shakespeare peppered his plays so frequently with insomnia, somnambulism, nightmares and possibly sleep apnea that at least one critic has argued the playwright himself was an insomniac, according to the journal of Clinical Sleep Medicine. In Hamlet's famous soliloquy, the tortured Prince of Denmark connects sleep with death several times—famously proclaiming, “To die: to sleep; / To sleep: perchance to dream.”

The Danish prince's oratorical anguish anticipated by several centuries connections that scientists today are beginning to unravel. Indeed, a growing body of evidence shows that sleep is as intimately twined with disease and death as Hamlet soliloquized. We may live in a less lyrical age, but science is giving us new insights into sleep's essential connections to health. Shakespeare today might well be moved to write of how science not poetry "is fetching jewels from the deep." Biostatisticians, epidemiologists, clinical psychologists and others are probing the mysteries of sleep, uncovering secrets about its connections to cognitive impairment in the elderly and psychological development of the young, and especially its associations with chronic diseases and ultimately its poetic kinsman, death.

An alignment of new technology and scientific approaches comes at a time when large studies reveal disconcerting data about American sleep, scientists are deploying new technology and approaches that link sleep to overall health. The frenetic pace of contemporary life with its 24/7, multimedia-saturated culture is having clear effects in the bedroom. “Chronic sleep loss is an under-recognized public health problem that has a cumulative effect on physical and mental health,” begins a 2008 CDC Morbidity and Mortality Weekly Report article. The article cites unpublished 2007 CDC data from epidemiologic surveys suggesting that average sleep duration has decreased in the U.S. during the past two decades. Significantly more Americans now experience problems sleeping at least a few nights a week than eight years ago: 64 percent in 2009, compared with 51 percent in 2001, reports the National Sleep Foundation. U.S. adults sleep on average 6.9 hours per night, according to a 2005 poll by the Foundation. (The CDC recommends 7 to 9 hours of sleep per night for adults, 8.5 to 9.5 hours for adolescents and up to 18 hours for infants.) Sleep deprivation and sleep disorders like sleep apnea (a breathing-related disorder) have been associated with health problems such as an increased risk of hypertension, diabetes, obesity, depression, heart attack and stroke.

At Johns Hopkins, a multi-disciplinary team including epidemiologist and pulmonary specialist Naresh Punjabi and biostatisticians Brian Caffo and Ciprian Crainiceanu are making connections between sleep apnea and chronic diseases. Meanwhile, psychologist Adam Spira is investigating the effects of sleep disorders on older adults' cognition and on their ability to care for themselves.

No longer a realm explored solely by poets, sleep—that essential, primal function of the human body—is increasingly recognized as a priority for public health researchers.

A Risk of Death

Meet Joe Higgins. He was 51 when he started having trouble getting a decent night’s sleep. The quality of his sleep had gradually declined for several years, but Higgins thought it was due to the medicine he was taking for his severe allergies.

“I came to dread the two o’clock meeting in the afternoon, because it was virtually impossible to keep your eyes open in that setting,” Higgins recalls, six years later. “And then you’re nodding off driving home from work.” After being tested at a Hopkins sleep center, he learned that his breathing during sleep was being interrupted on average 26 times an hour. The condition is known as sleep apnea (also called sleep-disordered breathing). About one in ten women and one in four men have sleep apnea, which is caused by the recurring collapse of the upper airway’s soft tissue. As the upper airway muscles relax, airflow decreases and oxygen levels in the blood fall. This briefly rouses the sleeper as they struggle to breathe.

Punjabi, an associate professor of Medicine with a joint appointment in Epidemiology at the Bloomberg School, prescribed an ongoing course of continuous positive airway pressure (CPAP) therapy. Higgins wears a mask during sleep that allows the CPAP machine to keep his upper airway clear. It quickly improved Higgins' sleeping. But this individual clinical success is just a precursor to a larger public health story. Punjabi enrolled Higgins in a study that is examining sleep apnea and diabetes risk. In Higgins' case, his glucose tolerance has shown marked improvement. “That was something that was important to me,” says Higgins, whose parents both had type 2 diabetes.

“More and more, we’re recognizing the health consequences of a variety of sleep disorders,” says Punjabi, MD, PhD.

In August, Punjabi and Caffo, an associate professor in Biostatistics, published findings in PLoS Medicine that link sleep-disordered breathing with an increased risk of “all cause” mortality, particularly for men ages 40 to 70.

“That’s a very important finding,” Crainiceanu says, one that was long suspected but never before shown. The findings also suggest that the increased risk of death is specifically associated

As large studies uncover disconcerting data about American sleep, scientists are deploying new technology and approaches that link sleep to overall health.

Ciprian Crainiceanu
More strange, more beautiful ... than the wings of swans ... .
with coronary artery disease, though more studies will be needed to confirm this. Drawing on data from more than 6,000 participants in the national Sleep Heart Health Study coordinated by Johns Hopkins researchers, the paper marks 15 years of data gathering and analysis. "I think it breaks new ground, especially in scientific terms," says Crainiceanu, an associate professor in Biostatistics. "These results are based on the largest community cohort study of sleep."

The study points to a surprising fact: Though sleep, as described by Keats, is "more secret than a nest of nightingales," it generates an enormous amount of data.

This plethora of second-by-second information can be both dream and nightmare for researchers.

The Architecture of Sleep
In the atrium of a Johns Hopkins Bayview Medical Center building, a mobile of blue spheres hangs in a surreal constellation. Deeper inside the building is a suite of seven bedrooms. Each room has a bathroom, television, furniture—and a modem-sized electronic unit, which gathers data on the sleeping occupant.

Welcome to the Sleep Study Center.

This type of research suite marks the gold standard for getting quality data about what happens during sleep. Here, people like Joe Higgins spend a night and have their sleep patterns assessed. Electrodes are affixed to various parts of the body to gather measurements. The sensors in each room send the data to a central hub, where Punjabi points to a page with more than a dozen graphs stacked atop each other. For each subject the sensors in each room measure. The sensors in each room affixed to various parts of the body to gather measurements. The sensors in each room send the data to a central hub, where Punjabi points to a page with more than a dozen graphs stacked atop each other. For each subject the sensors in each room

Electrodes affixed to various body parts of a sleep subject generate a plethora of second-by-second information that is both dream and nightmare for researchers.

"poly"—many, "somno"—sleep, and "graphy"—write).

"The thing about [studying] sleep is that it's a very, very quantitative field," says Punjabi. "You're measuring brain activity, and you're collecting data every second." He continues, "A hundred to five hundred times per second you're collecting EEG data. That's one of the most voluminous things in medicine."

Yet up to now, the methods for assessing sleep as a series of discrete stages have been "extremely crude." That's why he sees the work of biostatisticians Caffo and Crainiceanu as so important: they're helping fine-tune the picture from the growing volume of data. "It’s [a matter] of taking a tremendous amount of extracted data and making sense of it," says Caffo, PhD.

Scientists study our "sleep architecture"—the relative structure of our time sleeping portioned out among five stages, identified by EEG data: stages 1 through 4, plus REM (rapid eye movement) sleep. In The Family That Couldn't Sleep, D.T. Max describes the typical sequence: Sleep begins with rough alpha waves (stage 1), deepens into longer theta waves (stage 2), followed by sleep spindles, which take the sleeper into the profound sleep of the rolling delta wave of stages 3 and 4. These get interrupted periodically by the jagged lines of REM sleep.

Caffo and colleagues have managed to re-cast this conventional categorization of sleep as a sequence of five stages and uncover a new pattern that allows clearer correlations to a person’s health. In a 2008 paper in the Journal of Clinical Sleep Medicine, Caffo and Punjabi showed that two groups that seemed to have the same sleep architecture (meaning they spent similar proportions of sleep in the various stages according to conventional interpretation) were in fact very different in their vulnerability to disease.

Research on sleep-disordered breathing has traditionally been based on “composite” sleep-stage summaries, notes Caffo. These were high-level views that could only show the percentage of time spent in each stage of sleep. Caffo and Punjabi wanted to explore the data more precisely. So Caffo and his colleagues tapped two biostatistical tools—log linear and multi-state analysis—to analyze the multiple types of sleep data and tease out previously

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**COUNTING SLEEP: Disturbing Data on the American Dream**

| 70 million: | Americans who have a chronic sleep disorder or intermittent sleep problem |
| 77: | Percentage of older adults who are obese who report having a sleep problem |
| 10−15: | Percentage of U.S. adults who report having chronic insomnia |
| 13, 20: | Percentage of Americans who reported sleeping less than 6 hours a night in 2001, and 2009, respectively |
| 20: | Percentage of serious car crash-related injuries associated with driver fatigue, independent of alcohol effects |
| 1,500: | Lives claimed in the 100,000 car crashes caused annually by drowsy drivers |
| $50 billion, $16 billion: | Annual cost of lost productivity, and health care expenses, respectively, in the U.S. due to sleep loss and sleep disorders |
| 60–70: | Percentage of Americans who do shift work who suffer from insomnia or problem sleepiness |
| 12–18 million: | Estimated number of U.S. adults with sleep apnea, with more than half undiagnosed |

**SOURCES:** NIH, National Sleep Foundation, CDC, Institute of Medicine, National Highway Traffic Safety Administration
unknown differences in the transitions between the various sleep stages.

“These differences in transitions overlooked by traditional measures,” says Caffo, “may produce new clinical indices for measuring sleep disturbance.”

Subjects with sleep-disordered breathing had a greater number and higher rates of sleep-stage transitions than those without sleep-disordered breathing, the authors note. All these transitions are chopping up the duration spent in each sleep stage. Overall, they may get the same amount of REM sleep, but the REM sleep is composed of more, shorter episodes. Researchers believe people who experience rapid transitions may get the same number of minutes of REM sleep but it may not be the same quality.

“This new way of looking at the data essentially gives you a more complete picture,” says Caffo, “and a better predictor of disease.”

Crainiceanu, PhD, agrees. “You can see things that were impossible to think about before,” he says, such as differences in EEG data for smokers versus non-smokers or among different age groups. He describes the advances from the biostatistical viewpoint in terms of multi-resolution analytical tools: “This allows researchers to investigate multiple sub-groups while quantifying differences all the way from the fine detail of an individual’s raw EEG data (125 observations per second) to the heavily summarized individual’s sleep architecture.”

At the population level, these analytical methods are now allowing researchers to examine data from previous cohort studies in much greater detail than before.

This comes at a time when there is finally a rich trove of sleep data to be explored.

After nearly two decades, several long-term studies have amassed the nocturnal patterns of thousands of people. One, the Osteoporotic Fractures in Men Study, known as MrOS or more informally “Mister Os,” began in 2000 with 5,995 men ages 65 and older. Another, with 9,700 women in the same age range, began in 1986 in Minneapolis, Portland, Oregon and Pittsburgh and continued over 20 years. And the Sleep Heart Health study coordinated by Johns Hopkins recruited more than 6,400 people in cities across the U.S.

With the greater computational capacity gained in the last two decades, researchers can now perform more fine-grained analysis of that EEG data and can ask, Do any disturbances during segments of a person’s sleep correlate with their medical conditions? Answering that question with quantitative input “is extremely vital for moving this field forward,” says Punjabi. For him, the PLoS Medicine paper linking sleep disruption to mortality is more a prelude than a finale.

Instead of saying, “The story is done here,” he observes, “I think the story is just starting.” He calls for intervention studies that explore whether reversing or minimizing the physiological effects of sleep apnea and other sleep disorders can decrease the risk of mortality.

The Case for Treatment
Adam Spira, an assistant professor in Mental Health, sees opportunities for improving treatment for sleep disorders in psychology and medicine. Research fascinates him, and what really interests him is not simply the evidence that bad sleep may be linked to health problems, but the potential to ameliorate those problems if there is indeed a causal link.

“We have good treatments for bad sleep in older adults, whether it’s insomnia or apnea,” he says. Behavior therapy and cognitive-behavioral therapy (CBT), for instance, is effective in reducing insomnia, and CPAP therapy is useful for addressing apnea. “So,” he says, “it will be really good to know if treating these problems can improve those outcomes.” If so, some problems typically accepted as a product of aging may be treatable.

Spira, PhD, came to Hopkins in 2008 after a fellowship in geriatrics and geropsychiatry at the University of California-San Francisco (UCSF), where he looked at the sleep of older people in epidemiological terms. He received an invitation to come to Hopkins while he was working on studies of sleep in MrOS and the Study of Osteoporotic Fractures (SOF) with Katie Stone, a scientist at the California Pacific Medical Center Research Institute. Spira respects the team of Hopkins scientists working on sleep research, and was drawn by the impressive range of interdisciplinary collaborators. “You’ve got a biostatistician, you’ve got Naresh who is a pulmonologist and critical-care medicine doc, you’ve got a professor in epidemiology here, and then my PhD is in clinical psychology.”

With a major grant from the National Institute on Aging recently approved, Spira and colleagues at the Bloomberg School and the School of Medicine aim to delve further into the rich material of the Mister Os and SOF studies and detect links between poor sleep and functional decline. The five-year career development award will allow Spira to learn from mentors including Punjabi, Bloomberg School Mental Health Professor George Rebok, PhD, and his postdoc mentor Kristine Yaffe, MD, Psychiatry and Epidemiology professor at UCSF. The study will explore that data in more detail for connections between sleep disturbance and decline in performing daily functions such as housework and grocery shopping.

Punjabi sees that work as critical. “What’s really necessary—and this is what Adam’s starting to work on with the Mister Os study,” he says, “is objective, fine-grained monitoring of actigraphy, which is a nice way to look at sleep duration objectively.”

Spira first worked with actigraphy studies
Naresh Punjabi seeks to “unravel the complex tapestry that weaves sleep with our medical health.”

in California, measuring sleep disturbance using an actigraph, a small device that looks like a wristwatch with a blank face. Worn on the wrist, the actigraph contains a tiny accelerometer that measures movements as an indication of sleep and sleep disturbance. While less comprehensive than the sensors in a sleep center, actigraphy has the advantage of continuous collection for up to two weeks. “The new models are waterproof so you don’t ever have to take them off,” says Spira. Actigraphy data gets uploaded, run through a set of algorithms, “and that gives you all sorts of quantitative values representative of sleep parameters.”

Spira pulls up sample data on the computer in his office. “These are some of the sleep parameters,” he says. “Sleep efficiency, that’s the percent of the time in bed that you’re actually spending asleep. Here, this example is quite high—it’s 95 percent basically.” Sleep efficiency of under 80 percent is considered poor sleep.

Spira expects to devote the next five to 10 years to examining the link between late-life sleep disturbance and both cognition and function (which includes basic tasks such as self-feeding and bathing, as well as grocery shopping and preparing food). Knowing which aspects of bad sleep—short duration, fragmentation, etc.—lead to poor daytime functioning would help researchers develop treatment studies aimed at improving poor outcomes. “Can we prevent cognitive and functional decline? That’s the hope—that we’ll be able to change these unfortunate trajectories,” Spira says.

Those negative trends could possibly be pushed further toward the end of life to maximize quality of life measures, such as the ability to think clearly, the capacity to take care of yourself and others, and the ability to play an active role in the community.

“We may be closer to understanding how negative consequences emerge from bad sleep,” says Spira, and so, “from a public health perspective, we might better understand how to protect the health of this growing segment of our population.”

Perchance to Dream

Spira has launched a field-based actigraphy study, this one looking at the role sleep might play in quality of life among older African-American adults in Baltimore. His small project is piggybacking on a larger study of the Experience Corps, a national program that has recruited 2,000 older people to tutor and mentor elementary school students in 22 cities across the country, providing literacy coaching, homework help, role models and attention.

“I wanted to see the relationship between their sleep, as measured by actigraphy, and function, and whether over the course of four months, the sleep of those in the Experience Corps program improves more than the sleep of those in the control group,” he says.

It may be true, for example, that the physical activity involved in volunteering in schools every week could lead to better sleep, perhaps by increasing both physical activity and improving mood. That study will also expand the range of populations for which a sleep profile exists, notes Spira, whose project won him an award last spring through the JHSPH Faculty Innovation Fund.

Epidemiological studies such as these, coupled with ongoing advances in bioinformatics, hold the potential for dramatically improving health on a wide scale, says Crainiceanu.

“Every month there’s a new very large data-set study that has similar problems that we are able to address,” he says. “All of them are gaining strength from the current methodological developments. Studies that include images, such as MRIs, are one of the big areas that will benefit from this research, but there are many, many other areas as well.” Better ways to summarize large amounts of imaging data will help public health professionals sift through data, identify key trends and patterns more quickly, and test solutions.

“The research we have is oriented toward population level imaging and functional analysis,” Crainiceanu adds, noting that other groups are interested in their work. The challenge is to develop faster and better algorithms and a better infrastructure for these huge data sets.

The public health field is gaining new tools from the collaboration on sleep research, says Crainiceanu. The sleep findings have gained new robustness from the breakthroughs in analytical methods and led to fresh perspectives on how to look at vast data sets that are increasingly common across the field of public health. These broader benefits will be highlighted at a conference that the Bloomberg School’s Department of Biostatistics is planning for 2011, about statistical methods for very large data sets, such as those generated by sleep research, genomics research or observational studies.

“New technologies and modern computing are letting us better measure health and biology,” says Caffo. To more effectively use this new information, he says, we need new statistical methods.

Their collaboration, in Punjabi’s poetic words, “brings new insights to old problems and helps unravel some of the complex tapestry that weaves sleep with our medical health.” ☇
global classroom

Technology and pedagogical savvy are revolutionizing public health education.

LiveTalk, anyone?

By Mike Field
Illustrations by Joe Cepeda
It’s just after 7 p.m. on a Wednesday night in Baltimore, and from a recording studio on the second floor of the Bloomberg School’s Wolfe Street building, John McGready is on the air. Wearing a DJ’s headset and working from notes jotted on a small green cheat sheet, McGready has the easygoing banter of a drive-time radio host. The content of his monologue, however, is anything but drive-time.

“This is complicated material,” he says, reaching out with his left hand as if toward an imaginary blackboard. “You can’t hear it once and ‘get it.’ You have to ruminate on this material.”

His listeners—there are currently 70 signed in from as far away as Abu Dhabi—seem to agree. They are texting questions that appear on a large flat screen display mounted on the wall opposite where McGready is sitting, asking him to clarify issues of z scores and degrees of freedom and other subject matter covered in his class, “Statistical Reasoning in Public Health.”

Thanks to “LiveTalk” technology, McGready can respond verbally, and write and draw on a tablet that transfers the images to his and his students’ screens during the session.

McGready, PhD, is an instructor and assistant scientist in Biostatistics. He is also an Internet pioneer, having taught this and other online classes in the School’s distance education program for the past 10 years. He says tools like LiveTalk are very useful in helping him gauge how well students are following the material—something that’s easy to do in a traditional classroom lecture but trickier when teaching online.

“When we began this effort in 1997, there was no existing model, so it was largely a matter of saying, ‘Let’s try something entirely new.’ We ended up creating features that have helped to change teaching and pedagogy across the School.”

— James Yager, senior associate dean for Academic Affairs

The sessions, which McGready holds weekly, are one of several feedback loops built into the Bloomberg School’s distance education program. Other tools include hours of pre-recorded lectures; direct email contact with faculty; a threaded, content-rich bulletin board
PUBLIC HEALTH’S LOOMING WORKFORCE CRISIS

There is a storm on the horizon headed this way.

Experts in public health education warn of a looming workforce crisis with shortages already apparent in the highly trained personnel needed to meet today’s global health challenges. Meanwhile, an estimated 80 percent of America’s public health workforce lacks formal training.

There is a storm on the horizon headed this way. Take all together they represent, not so much a different way of doing the same old thing, but a new and improved way of teaching and learning, say faculty proponents.

“When we began this effort in 1997, there was no existing model, so it was largely a matter of saying, ‘Let’s try something entirely new,’” says James Yager, PhD, senior associate dean for Academic Affairs. “We ended up creating features that have helped to change teaching and pedagogy across the School, and have greatly improved it, in my opinion.”

By removing the geographic constraints of the traditional classroom, the Bloomberg School has also vastly increased access, redefining the profile of the School’s typical MPH student. Currently there are 210 students enrolled in the full-time, 11-month-long MPH program in Baltimore and more than 430 students in the part-time program, which is generally completed in two and a half to three years. The number of students matriculating in the part-time program has increased by 50 percent over the past five years.

“These programs have grown so rapidly because of need,” says Marie Diener-West, MPH program chair and the Helen Abbey and Margaret Merrell Professor in Biostatistical Education. “We saw that our part-time programs (CSLGE), as many as 45 percent of public health workers are expected to retire within the next five years. Already some states have vacancy rates as high as 20 percent in key public health positions, with, for instance, a reported nationwide shortfall of 1,200 epidemiologists.

But change is in the air. According to the Pew Charitable Trusts’ Government Performance Project, virtually every state has been examining the workforce issue as a key means of ensuring critical public health functions. In the past decade there has been a surge in the creation of new schools of public health. The state of Arkansas, for example, set aside 5 percent of its tobacco settlement funds to create a college of public health to provide training in high-need areas, such as epidemiology. And public health is suddenly a “hot” major at undergraduate schools around the country: At Johns Hopkins University’s Homewood campus, it has become the fastest growing, and very nearly the largest, undergraduate major.

Perhaps not surprisingly, the solution to meeting the public health workforce crisis comes down to money. In a 2006 report “The Public Health Workforce Shortage: Left Unchecked Will We Be Protected?” by the American Public Health Association, author Courtney Perlino, MPP, concludes that “ultimately, there needs to be an increase in federal funding for all of public health, not just those issues capturing headlines today.”

The nonprofit Public Health Foundation estimates that an immediate infusion of approximately $10 billion is needed to shore up the nation’s public health infrastructure. Such an increase would not only help to alleviate workforce shortages; it would also, in the quietly understated language of Perlino’s report, “lead to public health constituting more than three cents for every dollar in the United States spent on health.”

ALUMNI DISPATCHES

“Recently I analyzed data on motor vehicle crashes from 2003 to 2007 [involving] 16- to 19-year olds who died. What I found was astonishing! About 80 percent were drivers themselves or passengers in vehicles where the driver was less than 20 years old. For every teen driver killed, nearly two other individuals were killed. If traffic crashes involving teen drivers aren’t a public health concern, then I don’t know what is!”

— Andrea Ippel Barretto, MHS ’06

Read more from this and other dispatches by alumni working on the frontlines of global health: http://magazine.jhsph.edu/alumnidispatches
could be more widely available through distance education, and new technologies opened up the opportunity for students to take classes throughout different parts of the world. Many of our part-time Internet-based students are only in Baltimore or other onsite locations for several two-week periods, and the rest of the program is done over the Internet.” The availability of the distance education option for students around the world has been increased significantly over recent years by the addition of a wide range of online courses, and face-to-face instruction has extended from the School’s summer and winter institutes in Baltimore to locations such as Hong Kong and Barcelona, where students can fulfill some of the curricular requirements of the degree.

Experts say this expansion of access to top-flight public health pedagogy can’t come soon enough: A critical shortage of public health workers—across the country and around the globe—is looming, due to years of declining public health budgets and an oncoming tidal wave of retirements. (See “Public Health’s Looming Workforce Crisis.”)

The Association of Schools of Public Health (ASPH) estimates that it will be necessary to find 250,000 more public health workers by the year 2020 in order to return the U.S. to its former ratio of 220 public health workers per 100,000 of population—a not unrealistic goal in the age of global pandemics and a simultaneous explosion in chronic diseases like diabetes and asthma.

“There is a need for more and better-trained public health workers,” says David Trump, MD, MPH ’85, director of the Peninsula Health District within the Virginia Department of Health. “Local health departments have evolved from a clinical focus to a community health focus, which means we need workers who can work effectively in the community. That’s a different set of demands on the practitioner than even 10 years ago.”

Many, but not all, will need at least certificate-level training, while the demand for leaders with MPH and other advanced degrees will be acute. And this staggering number does not even begin to address the critical global shortage in public health workers, where, for instance, in sub-Saharan Africa, 11 percent of the world’s population carries 24 percent of the burden of disease—yet commands less than 1 percent of the world’s health expenditures.

Against this backdrop, distance learning and the Internet are likely to loom large in meeting the need for more and better training of public health professionals. The ASPH lists a dozen member schools that offer online MPH degrees, with many more schools offering continuing education and certificate training in public health online.

If now more than twice as many Johns Hopkins MPH students are enrolled online as on campus, how does that impact the meaning of the degree? And how can distance learning students be assured their educational experience—in classes, in their interactions with the faculty and other students—has the same breadth, depth and caliber as the more traditional classroom experience available to those who have the time and resources to come to Baltimore? These are not inconsequential challenges.

“This was a real concern when we first started these programs,” says Dean Michael J. Klag, MD, MPH ’87. “Will people be inculcated with the ethos and spirit of the Bloomberg School if they are not physically present? Will they look at this as a calling to a higher purpose or just an efficient way to transfer knowledge?” That underlying uncertainty was in part responsible for the decision to create a program that incorporates onsite visits so the distance-learning students have some direct personal contact with key faculty members and program directors. “We did not want to just put a video camera in a classroom, tape the lecture, and call that an online class,” Klag says. “But we decided from the start to spend a lot of time in design and planning our distance education program to make sure those students came away feeling part of the community. One thing that tells me we have succeeded is the surprising number of online students who travel to Baltimore to receive their diplomas in May at graduation—there are many each year.”

“As faculty, we are very cognizant that these aren’t correspondence courses,” says Dienne-West, PhD. “One of the ways in which we deliver an online education comparable to what our students experience when they come to Baltimore is by fostering synchronous communities where students and faculty can chat in real time through LiveTalk or by other modes such as a bulletin board. I would say that the level of engagement of our online students was the main
She notes that when her colleague John McGready compared outcomes in his online and onsite biostatistics classes, he discerned no significant differences in learning based on evaluations between the two groups. “The great advantage online is that everyone experiences the lecture on a one-to-one basis with the instructor and can move at their own pace,” she says.

At the Bloomberg School, turning subject matter knowledge into a best practices education is the responsibility of Sukon Kanchanaraksa, PhD, and his team of 26 professional instructional designers, technical writers, web developers, medical graphic illustrators, audio producers and editors, and others in the Bloomberg School’s Center for Teaching and Learning with Technology. Kanchanaraksa serves as the Center’s director and has taught online since the School’s first distance education courses premiered a dozen years ago, back when faculty recorded their lectures in a second-story walk-up studio in a Monument Street rowhouse.

The Internet is generations advanced since then, and the Bloomberg School now employs a state-of-the-art digital recording studio, but the focus has remained the same, he says: facilitating the learning that has to happen in each course. “It’s not about the technology per se,” says Kanchanaraksa. “We have instructional designers who can help find the appropriate tools and approaches to improve pedagogy in all situations.” Rule number one for the Center is that the tools don’t come first. “You don’t start a course because you have Twitter. You start with the educational objective and make choices from there.”

But even something as seemingly straightforward as identifying the educational objective for a course can be a fraught exercise for faculty who have no prior experience in pedagogical analysis. In medicine the “see one, do one, teach one” instructional tradition relies on students seeing a skill (such as suturing) modeled, doing it themselves, and then teaching someone else to do the same. The use of three different learning modalities—observing, practicing, teaching—is an age-honored educational practice; it’s how most university faculty learn to teach as they advance from undergraduate to graduate to doctoral studies. But learning by doing does not necessarily impart the sound theoretical underpinnings that are so necessary when adapting teaching to the oftentimes unfamiliar milieu of the online world. For that, Bloomberg School faculty members have a staff of professional instructional designers at hand. (See “The Art and Science of ‘Webagogy.’”)

Says Kanchanaraksa: “It’s the quality and attention to detail that makes all the difference. We focus on the learning that has to happen, and we have a team of experts who can help an instructor improve the teaching in a class.”

For their part, students have great flexibility in choosing how to learn the material. Each online class is divided by the audio engineers into discrete “chapters” that are labeled with a total running time and can be individually downloaded in MP3 format. Students can choose to view chapters with all slides and related materials on their computers or, if they wish, they can use the MP3 format to simply listen to the lecture as they drive to the lab or work out at the gym. (“So you never have to be without me,” McGready jokingly tells his students.)

“It’s a really good way to make it work for you,” says David Williams, MPH ’09, who lived and worked a demanding job in Rockville, Maryland, editing technical journals while earning his degree. After working from 8:30 a.m. to 5:45 p.m. he would have dinner at home and then “jump online and spend two to three hours listening to lectures or doing the other work.” It was, he says, the only way he could have earned his degree—plus it came with some unexpected insights that enriched the experience. “I took several classes with [International Health Professor] William Brieger including one called Training Methods and Continuous Education for Health Workers,” he says.

“And while that course was going on, Professor Brieger was actually out in the field in Africa doing his work. It was pretty neat to hear from someone who was working on the issues he was talking about.”
presentations are clear and concise. Every step along the way they focus on making sure course materials and student access via Adobe Presenter software. The website then receives a gaging presentation. The final recording, slides, and any related materials are extraneous "ums," then the whole recording is edited to create a fluid and engaging presentation. The final recording, slides, and any related materials are turned over to the web development team, which creates a final product that students access via Adobe Presenter software. The website then receives a final review from an independent quality control team.

The audio editor reviews the lecture and removes needless pauses and extraneous "ums," then the whole recording is edited to create a fluid and engaging presentation. The final recording, slides, and any related materials are turned over to the web development team, which creates a final product that students access via Adobe Presenter software. The website then receives a final review from an independent quality control team.

The process typically takes three months or more from start to finish. While the faculty preparation time is demanding, there are advantages, say faculty converts to online teaching. Among them: flexibility. Each class can be as long or as short as the subject matter requires, enabling faculty to avoid "the tyranny of the bell" that requires them to fit their material within rigidly defined time slots when teaching in conventional classrooms.

"We [wanted] to make sure students came away feeling part of the community. One thing that tells me we have succeeded is the surprising number of online students who travel to Baltimore to receive their diplomas at graduation."

—Dean Michael J. Klag

THE ART AND SCIENCE OF “WEBAGOGY”

When a Bloomberg School faculty member approaches the Center for Teaching and Learning with Technology for help in developing an online course, the first step is a meeting with an instructional design team.

"Generally we go to the faculty member’s office and spend some time talking about learning," says team member Sara Hill. "Some faculty are very theory-based in their approach, and others are more like, 'Just show me the data,' but it’s important to understand at the start what they think about teaching and learning."

Based on the instructor’s goals, the design team identifies the best online tools to facilitate learning. "What does the student need to know? How do we accommodate that need?" asks Hill. "The truth is that although we are hired by the University to serve the faculty, our ultimate customer is the students. We want to give them the most effective opportunities to learn."

The staff at the Center has a term for this approach—webagogy—which they define as the art and science of teaching faculty how to teach online. At every step along the way they focus on making sure course materials and presentations are clear and concise.

Typically anywhere from 10 to 16 recording sessions are necessary per course. Faculty come to each recording session with PowerPoint slides, which form the basis of their lecture. The team incorporates charts, graphs, diagrams, photographs—even video recordings—wherever their presence can improve teaching.

The audio editor reviews the lecture and removes needless pauses and extraneous "ums," then the whole recording is edited to create a fluid and engaging presentation. The final recording, slides, and any related materials are turned over to the web development team, which creates a final product that students access via Adobe Presenter software. The website then receives a final review from an independent quality control team.

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Lost during the months of intense, acrimonious debate about U.S. health care reform were common-ground priorities such as effective strategies that reduce costs. One such approach is Guided Care, a model of comprehensive, coordinated care for patients with multiple chronic conditions. In Guided Care, a registered nurse works in a primary care practice to coordinate care, engage patients and their family caregivers in self-management, and smooth transitions from hospital to home. The model was developed by Chad Boult, director of the Roger C. Lipitz Center for Integrated Health Care, and colleagues from Hopkins’ Medicine and Nursing schools. Using preliminary data from Guided Care’s three-year, randomized-controlled trial (which ended in June), Boult estimates the approach could save Medicare up to $15 billion per year while providing better care. With the stoic patience of a veteran health policy expert, Boult doesn’t expect Guided Care to be adopted immediately, though it has attracted interest from Congress and the Centers for Medicare & Medicaid Services. He hopes to nudge it into larger national trials soon. Boult recently shared his thoughts on the challenges and the future of chronic care with Johns Hopkins Public Health editor Brian W. Simpson.
As an expert in health and aging, how do you perceive the U.S. health care system?

Our system is designed to serve people who are basically healthy and then, once in a while, get sick or injured. But when people have five or six chronic diseases that are never going to go away and they all require care and medicines and visits to doctors, our system really doesn’t serve them very well.

Give us an example of how the system fails.

The example that I sometimes use is a hypothetical patient who has five chronic conditions that she’s never going to get rid of. In a typical year, two or three of those conditions might flare up, requiring visits to the emergency department and the hospital. Those conditions might be diabetes or hypertension, or maybe heart disease or depression. She gets some acute care in the hospital and rehabilitation afterward and then goes back home again and is perhaps seen in the following months by maybe a psychiatrist for the depression and an endocrinologist for diabetes. There’s also a primary care doctor involved, but the doctors aren’t communicating with each other. As a result, sometimes what one very well-meaning specialist might do might have an adverse effect on a different condition.

Patients like this are obviously older, frail and likely to be hospitalized. How can a Guided Care nurse actually make a difference?

Several ways. One of the first things the nurse does for a new patient is to go out to the home and do a comprehensive assessment. This includes learning all about their medical conditions and medications, but also the safety of where they live, whether their appliances work, what’s their nutritional status. The nurse looks in the refrigerator and the cupboards to see what the person’s really eating and assesses whether the person’s really able to take their medicines or not. Out of that comes a detailed plan for managing this patient’s conditions that includes both what the patient and the family are supposed to do, as well as the doctor and nurse. The nurse then monitors the patient every month, usually by phone. They’ll go over all the medicines and all the dietary restrictions and all the physical activity that the person’s doing and any necessary behavior change such as reducing salt or stopping smoking. The nurse also uses this opportunity to detect any deteriorating conditions. One of the ways that this works is by detecting problems early and treating them before the patient needs to be hospitalized. Nip it in the bud is the idea there. But let’s say the person does have a heart attack and needs to go into the hospital. The nurse works with the patient right through the hospital stay and makes sure that whatever was designed for the patient while she was in the hospital actually gets carried out after the patient goes home. A lot of times when the patient first goes home there can be a lot of confusion: Am I supposed to take all the old medicines plus all the new medicines? Or stop the old ones and start the new ones? Or what?

Tell us about your most recent study results.

We’ve been conducting a randomized trial for the last three years. It was conducted in eight sites in the Baltimore/Washington, D.C., area. It involved just over 900 older patients with multiple chronic conditions and 50 primary care doctors. Half of the patients received Guided Care, and the other half received the continuation of their usual care. Our study showed that Guided Care saves more money than it costs. The patients who enrolled in Guided Care were less likely to be admitted to the hospital and to visit the emergency room and have home care and visits to rehab. With all the expenses of having a nurse, there was still an average 11 percent reduction in the overall cost for the patient. To say that another way, each nurse saved about $75,000 for the system per year.

Wow.

I should point out that these results are preliminary. [They are] only the first year of the study and they didn’t reach statistical significance, but they were in a direction that was encouraging.

You’ve said that Guided Care could save Medicare $15 billion a year. What would it take to realize that savings?

The idea of disseminating this model so that it becomes the standard of care in the country, I think, is really what we’re talking about. First of all, it takes a payment source. Recall that the savings that I mentioned accrued to the health insurer, for example, Medicare. But the costs are accrued by the practice that has to hire the nurse. So there has to be a payment model by which the insurer pays the primary care practice to hire the nurse. That’s what it takes to get this off the ground because practices, frankly, are not going to spend on average $96,000 a year for a Guided Care nurse without having some way to recover that cost. Then, of course, there is the issue of supply. Are there enough nurses? There are probably 500,000 nurses in this country who have current licenses but are not in the workforce, and we think that many of those might come out of their early or semi-retirement for a job like this. In the randomized trial we asked our nurses how they liked this job… they say, “This is what I went into nursing for in the first place, the opportunity to make a difference in people’s lives, to get to know them over time, to help them in a real time of need.”

Recently you were named a Health and Aging Policy Fellow and will spend a year in Washington, D.C. Are you excited to get into the policymaking side of things?

Yeah, I’m fascinated. Those of us who are not in the government don’t really know what goes on inside the government. I call it the black box. We can give our advice and then we go away, and then they come out with a law. You never really know how effective you were in terms of giving them helpful information. So I’m really intrigued to live inside the black box for a year and really see how it works.

CHAD BOULT

Degrees: MD, MPH, MBA

Career Highlights:
Director, Health Services Research, Division of Geriatric Medicine and Gerontology, Department of Medicine, Johns Hopkins School of Medicine, 2003 – 2006
Director, Aging and Geriatric Medicine program, University of Minnesota Medical School, 2000 – 2001
Director, Family practice residency and Family Medical Center, University of California San Diego Medical School, 1985 – 1987

Recent Awards:
Health and Aging Policy Fellow, 2009
UCLA David H. Solomon Award, 2008
Archstone Foundation Award for Excellence in Program Innovation, 2008

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The Inside Story of Smallpox Eradication

Few believed it was possible. For millennia, the smallpox virus visited misery and death upon humanity, claiming hundreds of millions of lives. Then, in 1966, the World Health Assembly launched the smallpox eradication campaign. D.A. Henderson led the successful global effort, which enlisted more than 100,000 people and demanded extraordinary tenacity, creativity, organizational skills and a willingness to break bureaucratic rules. In the following excerpts from his new book, Smallpox—The Death of a Disease, Henderson, MD, MPH ’60, dean emeritus of the Bloomberg School, shares his insider stories from the consummate public health triumph.

Preface
Smallpox has played a pivotal role in every era of human history. No disease has been so greatly feared or worshipped—no disease has killed so many hundreds of millions of people nor so frequently altered the course of history itself. As I was growing up, however, I knew smallpox only as a name, a disease against which all children had to be vaccinated. That abruptly changed in 1947.

Smallpox suddenly appeared in New York City—two smallpox patients were discovered, but no one knew how or where they had acquired the infection. Their movements were traced, and more smallpox patients were discovered. Emergency vaccination programs began—first for the hospital staff and the patients where the cases were isolated and then for residents of the apartments where they had lived. As more smallpox patients were found, the vaccination program extended to other hospitals and to other parts of the city. Eventually, the source was discovered: a visitor from Mexico who had become ill and died five days after his arrival. During his stay in a hotel, 3,000 people from twenty-eight states had booked rooms. Health staff sought to trace and vaccinate all of them. The city was in turmoil. A decision was finally made to vaccinate the entire urban population. Six million people were vaccinated during a four-week period. This massive effort was the response to an outbreak that consisted of only twelve patients, two of whom died.

Berton Roueché, the respected New Yorker medical writer, vividly described the evolving events, the threat, and the terror in an article “The Man from Mexico.” He quoted from a doctor’s description: “The patient often becomes a dripping, unrecognizable mass of pus by the seventh or eighth day of the eruption. The putrid odor is stifling, the temperature often high (107˚ has been authoritatively reported), and the patient frequently in a wild state of delirium.” For me, the pervasive concern and fear of smallpox was startling and yet I had known nothing of this disease until its unexpected appearance in New York.

Fourteen years later, in 1961, I would be assigned national responsibility for dealing with smallpox, should it be imported into the United States. My position was chief of the surveillance section at the U.S. Communicable Disease Center (CDC). It was a time of high anxiety. Major smallpox epidemics were then erupting across India and Pakistan. Travelers flying by jet aircraft were rapidly increasing in number, and some were infected with the smallpox virus. From 1958 through 1960, the disease had been imported into Europe from Asia six times; eleven more importations occurred in 1961. By the end of 1963, twenty-three importations had resulted in nearly 400 cases. Not surprisingly, we had a number of false alarms in the United States—primarily patients with chicken pox. I assumed that it was only a matter of time before we would have to cope with smallpox.

A Program in Its Infancy
On October 26, 1966, I arrived in Geneva to face stark realities inherent in assuming the position of chief of the Smallpox Eradication Unit—to direct a global program intended to reach more than 1 billion people in fifty countries. I was thirty-eight years old and had a mere ten years of public health experience. Many thought I looked considerably younger than thirty-eight; certainly I lacked the maturity and gravitas expected of a WHO unit chief, few of whom were then under fifty.

Countries, Fiefdoms, and Short-Circuiting the Bureaucracy
The regional offices of WHO were important components of the administrative structure. For smallpox eradication, they were more a hindrance than a help. All WHO member countries belonged to one of the organization’s six regions. In 1967, four of the regions included countries with known endemic smallpox. One regional smallpox eradication program adviser was allotted for each of three—Southeast Asia (SEARO), Eastern Mediterranean (EMRO), and the Americas (PAHO). Two advisers were allotted for the African Region (AFRO)—one for eastern Africa, based in Kenya, and one for western Africa, based in Liberia. The advisers were selected and appointed by each regional director without reference to our unit at headquarters.

The regional directors considered themselves all but autonomous. After Dr. Halfdan Mahler became director-general in 1973, he often said to me, “You have to remember that WHO is, in fact, an Association of Regional Offices, not a World Health Organization.” The regional directors were each elected for four-year terms by a majority vote of that region’s member countries. Gaining or retaining a country’s vote required skillful politics, and such factors inevitably played a role in important decisions such as the selection of qualified staff and allocating of budget funds.

The regional directors interpreted the initiatives of the World Health Assembly as being primarily advisory. Some they accepted, some they ignored, and some they modified to suit their own and the region’s particular needs and agendas. Given the director-general’s openly expressed skepticism about smallpox eradication, it was not surprising that there was little support for smallpox eradication in the regions. Two regional directors were passively or openly hostile to the program; one largely ignored it; and one actively opposed it. Fortunately, the one who most strongly opposed the eradication program was replaced through election by a strong supporter a year after we began.

The regional offices added a dysfunctional layer of bureaucracy for communications with country program directors and WHO advisers. Recall that at the time of the program, there were no e-mail facilities, no mobile phones, and no fax machines. Telex and ordinary telephone calls were expensive (and not always technically possible).
Personal contact and correspondence by mail were our only reliable routes for communication. WHO policy required, however, that all correspondence with countries had to pass through the regional offices. But this was more than simply a routing of memos. For example, if I wanted to communicate with a smallpox program adviser in Uganda, my letter had to go first to the African Regional Office whose office was in Brazzaville, Republic of the Congo. It would be read by one of the staff, who might eventually prepare a draft forwarding memo for the regional director’s signature—a deceptively simple procedure that often required several rewrites and could take weeks. The recipient, the WHO country representative, would then consult with our WHO smallpox eradication adviser. A reply followed this track in reverse. This bureaucratic tangle ensured that four to five months might elapse between the time I sent a simple query and received a reply—if one came at all. Eventually I resolved the problem by simply sending original copies of memos to the regional office, as directed, and carbon copies directly to the recipient. However, this added another wrinkle because the WHO mail pouch did not carry personal mail and the copies were so regarded. Regular postal service worked reasonably well, although it often cost me 100 to 150 francs a month to send my documents. It was worth it.

The direct system of communication sometimes created its own problems: once we received a telex from Uganda asking that 2 million doses of vaccine be sent urgently. We sent the vaccine by air the following morning. Five months later, the regional office wrote to report an urgent request from Uganda for 2 million doses of vaccine. We did not know whether this was a new request or the one we had dealt with five months previously. (It was the latter.) The policy of quietly short-circuiting the regional office, when necessary, continued for years and, surprisingly, was never questioned, if indeed the regional directors ever learned about the practice.

**Indonesia—A Remarkable Achievement with Few Resources**

The program began in July 1968 in Java, one of the world’s most densely populated areas. Thirteen “advance teams” were established. Each had a vehicle and was headed by an Indonesian medical officer who had been given a month’s special training. WHO supplemented the medical officer salaries so they could serve full time. The teams’ primary functions were to work with local authorities to promote the vaccination program, to provide some sort of supervision to vaccinators, and to try to establish the regular reporting of cases to the national smallpox program headquarters. At first these activities seemed to have little effect on smallpox incidence. However, as the importance of surveillance–containment became apparent, the teams in two of Java’s three provinces cut back on all routine vaccination and undertook special searches in order to find and contain cases. It was during this period that the first use was made of schoolchildren and teachers to report outbreaks, and the idea of the WHO Smallpox Recognition Card came into being. As the number of smallpox cases declined to low levels in a province, the teams moved on to more heavily afflicted areas. It was a surprise to find that despite the density of population, the spread of smallpox remained concentrated geographically. Long-distance spread to more distant areas was infrequent.

In Indonesia, the reported numbers of cases of smallpox for 1967 and 1968—13,000 and 17,000, respectively—depicted a problem that was much less serious than the program staff had anticipated. [Dr. Jacobus] Keja, then serving as the SEARO regional adviser for smallpox, decided in 1968 to undertake a population-wide survey of facial smallpox scars. From this he could develop an estimate of the actual numbers of cases that had occurred during 1967. He found that the true number was more likely to have been at least 100,000 cases. The minister of health was profoundly skeptical and asked that his own Indonesian statisticians review the data and reach their own conclusions. They concluded that the true number of cases was actually even higher, more likely 200,000 to 500,000 cases. Interest in the program at the highest levels of government soared, and additional Indonesian government resources were quickly made available.

The development of a surveillance system was one of the more remarkable achievements in Indonesia. It became fully effective in early 1970. The architect was an Indonesian medical officer, Dr. A. Karyadi. He standardized reporting forms and established a goal of receiving all reports within two weeks from provinces and within three weeks from the outer islands. This required imagination and innovation. The postal service was limited in its geographic scope and was unreliable at best. But creative methods were found—enlisting bus drivers, military personnel, special messengers, and businessmen as couriers. By September, Karyadi reported that 95 percent of the weekly reports were being received from all reporting sites on two of the main islands. This contrasted to the situation only a year before, in which only half of the units had reported—with delays of twenty-one weeks. In May 1970 he began issuing a weekly surveillance report, much as [statistician-epidemiologist] Leo Morris had done in Brazil.

As the advance teams experienced increasing success, routine vaccination efforts declined, case searches increased in number and intensity, and additional vaccinators were enlisted to help in containment vaccination. What appeared to be the last cases in Indonesia were discovered in December 1971—little more than three years after the program had begun. Four weeks passed without cases, and then forty-five cases were notified from a subdistrict only seventeen miles (twenty-eight kilometers) from the capital. Special teams began a rapid search and vaccination effort, but 160 cases were discovered before the last occurred in late January 1972.

The success of the Indonesian program, given the obstacles and paucity of resources, was a remarkable achievement. International support was minimal, amounting to only $1.3 million (little more than one cent per person); it included 24 vehicles, 430 motorcycles, and 3,100 bicycles. Several of the exceptional senior staff were eventually recruited to serve as WHO advisory staff in other countries. One of them, the Indonesian program director, [Dr. Petrus] Koswara, forty-three years of age, was the only WHO staff member to die while working in the program. He succumbed to a heart attack in 1974 in Ethiopia.

**The “Eradication-Escalation” Strategy**

One of our first field operatives in Nigeria was the very tall, irrepressible Dr. William Foege, whom I had recruited from his Lutheran mission post in Eastern Nigeria. Foege had previously worked with me at the CDC, most recently in the smallpox unit, and he welcomed the
The last cases in the whole of West Africa were thought to have occurred in October 1969, less than three years after the program had begun. Until March 1970 surveillance and search operations failed to detect other cases. An evening to celebrate the success of the program was in progress when a report was received of a suspect smallpox case admitted to a hospital in Northern Nigeria. Foster himself drove some two hundred miles to the hospital, confirmed the diagnosis, and undertook a nighttime emergency vaccination program. Some thirty active and recovering patients came through the line. In all, seventy-five cases were eventually discovered before the outbreak was stopped. The final case occurred in May 1970—the last in West Africa.

A Smallpox Surveillance Team—Courage and Dedication

Under the direction of [Dr. Abdul Mohammed] Darmanger and [Dr. Arcot] Rangaraj, the Afghani field teams became a remarkably dedicated and courageous group. The investigation of a rumored outbreak in a northern mountainous area is illustrative. The team was sent on horseback to investigate but encountered three-foot-deep snow and had to turn back. They tried again by another route but again encountered snow. The horses were abandoned and the team continued on foot for four days to get to the outbreak area. They moved from village to village vaccinating and checking for cases as they went. In all, they spent six weeks in the middle of winter containing the outbreaks. When it was possible to carry out a thorough search of the area in the spring, no subsequent cases of smallpox were found.

Meanwhile, the mass-vaccination programs using the jet injectors had proved to be remarkably effective. Special teams checking on vaccination coverage found that vaccinators were reaching more than 80 percent of the villagers. By September 1968, when the “Eradication-Escalation” strategy got under way, almost 60 million of the targeted 110 million vaccinations had already been given; fifteen of the twenty countries were free of smallpox. In Nigeria, with nearly half of the West Africa population, smallpox incidence had fallen dramatically. The special strategy did play a significant role, however, in Guinea and Sierra Leone, where operations began a year after the other programs.

In 1970, I was visited in Geneva by representatives of the Anyanya Resistance Movement—rebel forces who were active in southern Sudan. They said that smallpox was not present in their area, but they wanted the vaccine because they were afraid of smallpox being brought into the area by Ethiopian migrants. When we asked how we could get vaccine to them, they said that they regularly took supplies from northern Uganda into Sudan, traveling on foot for seven to ten days through the forests. It was in everyone’s best interest that they have the vaccine—but the Sudanese government could not vaccinate in the rebel-controlled areas, and WHO could not provide vaccine to the Anyanya. The dilemma was resolved by giving quantities of vaccine directly to the resistance movement’s leaders and recording the amount as “lost to inventory.” After the war ended in 1972, Sudanese staff found that there were surprisingly large numbers of vaccinated residents in the southern rural areas, but no cases.

Foege concluded that the surveillance-containment component of the eradication strategy could prove to be more effective than we had anticipated—that it might be possible to stop transmission even before a mass vaccination campaign could be completed. A year later, in May 1968, he proposed this to the CDC staff for implementation throughout West Africa. The effort was to be labeled “Eradication-Escalation.” The one country where implementation of the strategy was delayed was, ironically, Nigeria. There had been serious concern that the Biafran civil war might spread more widely throughout that country and stop activities altogether. Thus, it was decided to put all possible effort into vaccinating as many people as possible as quickly as possible, in order to limit the size of potential subsequent outbreaks should the program be interrupted by war.

challenge of the new eradication program. (He was eventually to become director of the CDC and later of the Carter Presidential Center.) In November 1966, before most personnel and equipment had reached the field, Foege and two CDC staff members arrived in Eastern Nigeria. They soon received reports of smallpox cases from missionaries and quickly worked to control them. Using borrowed motorbikes and a limited supply of vaccine, they successfully contained three outbreaks simply by vaccinating household and village contacts. They discovered that the first cases had come into the area from Northern Nigeria. In an effort to discover other outbreaks, they recruited a missionary-based radio network to help report cases; subsequently, other health units were included in the network. The smallpox cases were occurring primarily along the northern tier of the region, and so, as more vehicles and vaccine became available, they focused on this area. By the end of May 1967, they had detected and contained 754 cases and vaccinated about 750,000 of the 12 million Eastern Nigeria inhabitants. Cases had rapidly diminished in number, and finally some weeks went by with no new cases being discovered. On May 30, Eastern Nigeria proclaimed itself the independent nation of Biafra. Active fighting broke out, and the CDC team was forced to flee the country. Later, Red Cross workers and others working in Biafra reported that they had encountered no smallpox cases. Smallpox transmission appeared to have been stopped by a vaccination program that had reached less than 10 percent of the population.

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