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LIFE AFTER DEATH

In February, a biologist gunned down three colleagues at the University of Alabama, Huntsville. **Meredith Wadman** reports how their department is trying to move past the tragedy.

Last month, Joseph Ng, a biologist at the University of Alabama, Huntsville (UAH), sat down with very mixed feelings to write a job advertisement for a new chair of the biology department. The provisional draft said that the department was seeking "an energetic and visionary leader" who could preside over the hiring of several junior faculty members.

What the ad didn't talk about, and couldn't possibly describe, were the events that left so many holes to fill.

On a Friday afternoon in early February, Amy Bishop, an assistant professor in the department, pulled out a black 9-millimetre pistol during a biology faculty meeting. "She just went down the line", wearing a look that was "cold, very cold", says Ng. At point-blank range, Bishop shot five of her colleagues in the head, killing three of them and critically wounding two others.

Ng, seated at the opposite end of the table, thought she would murder them all.

In the space of seconds, Bishop cut the 14-strong faculty by more than a third. Ever since, the survivors have been struggling with the enormous task of repairing the shattered department even as they try to heal their own emotional wounds. With 473 undergraduate majors, the biology department is the second largest on the Huntsville campus, and the shooting left nine courses without teachers. Twenty-one master's and doctoral students suddenly had no mentors. And seven research grants lost their principal investigators (see 'Keeping research grants alive').

Administrators and faculty members have rallied to keep the department running: they found substitute teachers, temporarily recalled the department's previous chairman and his assistant from retirement, and sought new mentors for graduate students. They took over the orphaned grants (except for Bishop's own project) and added dozens of student advisees to their lists of responsibilities — all on top of carrying their own teaching and research loads. "Right now, it's a sort of managed chaos. As each thing comes up, we deal with it," says Debra Moriarty, a biologist who is also dean of graduate studies and was in the conference room that day in February.

The surviving faculty members know that their success or failure will have effects well beyond the campus. The city of Huntsville has been building itself into a regional biotechnology research hub and has relied on the biology department to supply many of the ideas and scientists that feed that enterprise. Such ambitions were dealt a blow by Bishop's attack — the latest of the mass shootings that have become all too common on US campuses.

This weekend, the remaining faculty members in the Huntsville biology department will take a moment to celebrate the graduation of 40 biology undergraduates, four master's students and a PhD candidate. But it will be only a temporary respite. All but two of the surviving faculty members witnessed the shooting and must cope with having seen friends gunned down before their eyes and thinking that their own turn was seconds away. In the aftermath of the shooting, the biologists attended counselling sessions, but the true scale of the loss is still sinking in. "There are times when you feel very, very empty," says Ng, who has carried out research in structural biology in the department for 12 years.

On 12 February at 3 p.m., members of the biology faculty gathered for a meeting in Room 369R — a small, windowless conference room tucked away in a corner of the Shelby Center for Science and Technology, where the biology department occupies the whole of the third floor. Budgeting issues were on the agenda and attendance was good: 12 of the 14 faculty members squeezed around the table. Stephanie Monticciolo, the department's staff assistant, joined them to take notes. Bishop arrived shortly before the meeting started and positioned herself at the corner of the table nearest the door. Roughly 50 minutes into the meeting, she produced what Ng remembers as "a big, black pistol".

Aiming for the head in each case, Bishop fired systematically, getting off at least five rounds in what survivors say was probably 20 to 30 seconds. Starting on her immediate right, Bishop aimed at the face of Gopi Podila, killing the department's affable chairman, who was a nationally recognized plant biochemist. She then shot Monticciolo in the left temple, gravely injuring her.

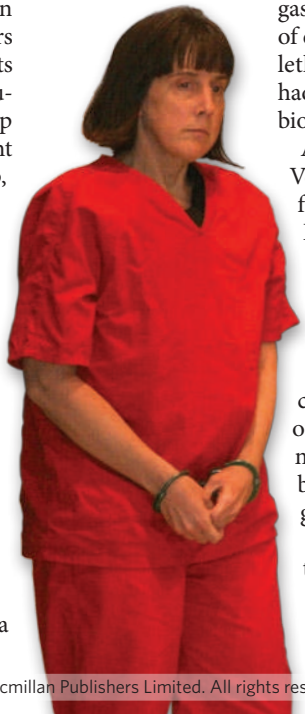
Bishop turned to her left and killed Adriel Johnson, a gastrointestinal physiology expert, who had made a career of encouraging minority students into science. The next lethal shot hit plant scientist Maria Ragland Davis, who had come to the university from Research Genetics, a local biotechnology firm.

A ricocheting bullet or bone fragment hit Luis Cruz Vera, a molecular biologist and the department's newest faculty member, who sustained a minor chest wound. Bishop then fired at Joseph Leahy, sending a bullet slicing through his skull and critically wounding him. She pointed the gun next at Moriarty and pulled the trigger, but the gun jammed and wouldn't fire.

After Bishop stepped into the hall, the survivors locked and barricaded the door with a coffee table and called the police. Bishop was arrested a few minutes later outside the building and has been charged with capital murder and attempted murder. She is being held without bail while prosecutors prepare to bring her case before a grand jury.

Bishop's husband, James Anderson, whom she called to pick her up after the shooting, was briefly detained by police and released. The couple has four children, aged 8 to 18 at the time of the shootings.

Amy Bishop opened fire in a faculty meeting.



R. CONN/*THE HUNTSVILLE TIMES*/LANDOV/PA IMAGES

THE DEPARTMENT THAT WAS

On 12 February, Amy Bishop attacked her colleagues during a faculty meeting in a small conference room in the biology department. Bishop killed three people and wounded three others.

The dead

Adriel Johnson studied gastrointestinal physiology with an emphasis on its neural regulation. He helped recruit and mentor scores of minority students.

Gopi Podila, the department chair, was a plant molecular biologist and had worked to develop Huntsville as a biotech centre.

Maria Ragland Davis was a senior plant scientist at the biotech firm Research Genetics before moving to UAH, where she taught cell and developmental biology.

The wounded

Joseph Leahy sustained a major head wound and a severed right optic nerve. He plans to return to research on the biodegradation of hydrocarbons.

Luis Cruz Vera studies the regulation of gene expression. He suffered a minor chest wound and was back at work the following week.

Stephanie Monticciolo was the department's staff assistant. She was seriously wounded in the shootings and spent weeks in hospital.

UNIV. ALABAMA, HUNTSVILLE

Huntsville, nicknamed 'Rocket City', has been a space- and engineering-science Mecca ever since 1950, when German rocket scientist Wernher von Braun was brought to the tiny cotton town to develop ballistic missiles for the US Army. Today, Huntsville and its suburbs boast a population of 387,000, with a higher percentage of engineers than any other US city.

A decade ago, as human-genome sequencers raced to the finish line, biologists in Huntsville decided it was time to put their city on the map for a different reason. They set themselves the ambitious goal of building Huntsville into a biotechnology hub; the region's answer, in spirit if not in size, to the San Francisco Bay Area (see *Nature* **453,** 818–820; 2008).

They were led by Jim Hudson, a local entrepreneur whose biotech reagents company, Research Genetics, had been bought in 2000 by Invitrogen of Carlsbad, California, for more than US$200 million. Hudson, working with an anonymous donor, eventually launched the non-profit HudsonAlpha Institute for Biotechnology to conduct genomics research, educate the public and provide a home to fledgling biotech firms. The institute opened its doors in 2008, in a huge research park three miles from UAH. Today, it houses 13 of the city's 20 biotechnology companies.

Ties between HudsonAlpha and the UAH biology department are tight. Many graduates from the department have gone on to work at the biotech start-ups housed at HudsonAlpha, and half of the institute's academic faculty members are adjunct professors at UAH. One of the many tenants at the institute with links to the biology department is iXpressGenes, which Ng launched to synthesize genes and enzymes for researchers.

Within days of the attack, HudsonAlpha's scientists were stepping in to help. They teamed up to take over Bishop's neuroscience class. And the institute has taken in half of the now-mentorless doctoral students, who have been doing rotations in HudsonAlpha labs to find a new PhD adviser. Rick Myers, who directs the institute, is also helping in the search for a new UAH biology chairman. That person will be expected to work closely and collegially, as the late Podila did, with HudsonAlpha, says Ng.

There is particular concern about supporting the university's interdisciplinary doctoral programme in biotechnology, which started in 2001 and is headed by Ng. "For biotech to succeed here and for HudsonAlpha to succeed, we need people coming through that [PhD] programme," says Troy Moore, an entrepreneur at HudsonAlpha who studied biology at UAH. He went on to co-found Huntsville-based Open Biosystems, which was acquired in 2008 by Thermo Fisher Scientific of Waltham, Massachusetts. One of his first thoughts on learning of the shootings, Moore says, was: "Oh no, who's going to want to come into that programme?"

But UAH administrators are confident it will survive. "The faculty members who put the PhD programme together were actually very astute in making sure that it wasn't built on just one or two faculty members," says Vistasp Karbhari, the UAH provost. "Normally I would worry about a programme [in this situation]. In this case, I am not worried."

"She pointed the gun at me again and it clicked."

One of the longest-serving professors in the biology department is Moriarty, an outgoing scientist who studies growth-factor signalling. A department stalwart since 1982, Moriarty had become in recent years one of Bishop's closest colleagues. The two were even talking about submitting a grant proposal together to the National Institutes of Health to study an enzyme that is thought to inhibit breast cancer.

Moriarty was glad to make the faculty meeting that Friday in February because her commitments as a dean often prevented her attending. As the meeting neared its end, Moriarty was jotting something on her notepad when the first shots rang out. By the time Moriarty looked up, Bishop had already hit two people and was rapidly selecting new targets. "There was only a second or two seconds between" each shot, Moriarty says. "At that point I realized what was happening. And all I thought was: 'This has to stop'."

Moriarty crawled under the table and grabbed one of Bishop's legs, pleading with her to end the attack. Bishop freed herself, chased Moriarty to the room's doorway and pulled the gun's trigger. It just clicked.

Moriarty rolled into the corridor outside and Bishop followed her. Moriarty saw "a very, very evil-looking stare" in the face of her colleague. "She pointed the gun at me again and it clicked," Moriarty recalls. "At that point, I kind of threw myself back into the room and shut the door. As I was doing that I heard 'click, click, click'."

Bishop had been quirky and outspoken ever since she arrived at the university in 2003. She came to Huntsville from Harvard University in Cambridge, Massachusetts, where she had earned her PhD a decade earlier. During a postdoc position in Bruce Demple's lab at the Harvard School of Public Health in Boston, she had studied the role of nitric oxide in central nervous system injury and diseases. At UAH, she continued that research, along with teaching introductory neuroscience, anatomy and physiology.

She also spent what some colleagues considered an inordinate amount of time developing a portable cell incubator with her husband, a biologist and computer engineer. They helped found a company, Prodigy Biosystems, to license the incubator from the university and commercialize it. The device has drawn $2.25 million in funding from local investors — $1 million of that since early March — making Bishop and Anderson a local biotech success story. Dick Reeves, the chairman of Prodigy Biosystems, says that the company formally parted ways with Bishop's husband in April, although Anderson says he has not yet accepted the severance agreement offered by Prodigy.

All that outside activity did not help Bishop — who turned 45 just before the shooting — when it came to her tenure decision. She was denied tenure in March 2009 and the university rejected her appeal in November. After the tenure denial, "she started to get a lot more agitated about things", says Moriarty. Bishop found someone who told her how each of her colleagues had voted on her tenure application. According to Moriarty, the decision "was not super close".

B. DILL/*NATURE*

Survivors: Debra Moriarty and Joseph Ng.

Moriarty has no doubt that the right call was made on Bishop, who had a history of causing graduate students to leave her lab in search of more congenial work environments. At the time of the shootings, Bishop was not supervising any PhD students.

"Her teaching was weak," says Moriarty. "And her research output was very weak." She had received repeated warnings in her annual reviews to publish more papers, says Moriarty. In the past three years, Bishop published two papers in the *Journal of Neurochemistry*, and one in the *International Journal of General Medicine*, which includes three of her children as authors.

Yet Moriarty is hard pressed, in hindsight, to find red flags. Bishop was vocal, and highly strung, but so are lots of academics. She had a big ego, but so do plenty of other scientists. "As long as she worked here, she was just sort of odd in her reaction to things. But not violent," Moriarty says.

Within days of the murders, however, Bishop's history of violence emerged. In 1986, when she was 21, Bishop shot and killed her 18-year-old brother with her father's shotgun, which was ruled to be an accident. Last month, an inquest into that shooting was held, and the District Attorney in Norfolk County, Massachusetts, may decide to seek an indictment against Bishop in her brother's death.

Bishop was also charged with assault in 2002 after she punched a woman in the head in a Massachusetts restaurant; the woman had taken the last child's booster seat there. Bishop was sentenced to probation in that case.

Nearly a decade earlier, Bishop and her husband were both questioned by law-enforcement authorities in connection with a mail bomb sent to Paul Rosenberg, a neurologist and neuroscientist at Children's Hospital Boston and Harvard Medical School. Bishop had worked for Rosenberg as a postdoc for eight months, until the end of November 1993. He received the bomb in December of that year after a discussion with her about whether he would be able to write her a strong letter of recommendation. That case has not been solved, but the US Attorney's office in Boston issued a statement after the February shooting, saying, "We have commenced a thorough review of the information related to this incident to confirm that all appropriate steps were taken in that matter." Anderson says the case was closed in 2001 and he told *The New York Times* in February that he and his wife had nothing to do with the bomb.

On 11 February, the day before the Huntsville shootings, Kimberly Hobbs, a third-year PhD student in biology, was wrestling with a problem: she had to take blood from rats for her studies of pancreatic function in diabetes, but she always seemed to miss the tiny veins in their tails. She sought out her mentor and thesis adviser, Adriel Johnson, for help. "Watch what I'm doing and you'll be able to do it too," said Johnson, showing Hobbs how to infuse the tail vein with blood by stroking it from the base to the tip, and how to

Keeping research grants alive

Universities and federal funding agencies have experience transferring the occasional grant from one faculty member to another because of illness, death or other unexpected circumstances. But in the shooting on 12 February, the University of Alabama, Huntsville (UAH), lost principal investigators on seven projects in less than a minute.

The grants range from a US$415,000 National Science Foundation (NSF) award for the acquisition of a confocal microscope to a $22,000 study of silver nitrate for battling the superbug, methicillin-resistant *Staphylococcus aureus*.

In general, agency grants are made to institutions, and not to individuals, meaning that when unusual circumstances arise, universities can transfer leadership.

Several of the UAH grants were within months of completion; they have been taken over by Joseph Ng and Lynn Boyd, two surviving professors in the biology department. The university also requested, and received, a one-year extension on an NSF grant on which the late Maria Ragland Davis had been principal investigator. Boyd will take over that project, too, which uses proteomic analysis to assign function to fungal proteins.

Gloria Greene, a grants administrator at UAH, says that the funding agencies have been sensitive to the university's circumstances. The NSF in particular asked if UAH wanted to extend the time period for the grants involved.

Only one of the seven grants will not survive: this was a $219,750 award from the National Institutes of Health to elucidate mechanisms of nitric oxide resistance in motor neurons. It was held by Amy Bishop, the biology professor who is now in jail. University administrators have asked the agency to terminate that research grant. **M.W.**

insert the needle directly on top of the vein.

Johnson had been the first faculty member Hobbs had met when, as a high-school senior from Chicago, she toured the Huntsville campus in 1998 with her mother, trying to decide between UAH and closer-to-home competitors such as the University of Minnesota.

Meeting Johnson clinched her decision. It wasn't only that he was African-American, like herself. The man's demeanour reassured Hobbs and her mother. "We felt that he genuinely cared about students and wanted you to do well." But Johnson hardly pampered his recruits. On the contrary, he was known for his tough love, which included requiring them to work extra hours designing lab experiments.

Without him, Hobbs is preparing for biology and biochemistry cumulative exams this summer as well as searching for a new thesis adviser. No remaining UAH biologist works in her area, so Hobbs has been observing in several labs at the HudsonAlpha Institute, and is likely to move her doctoral work there this summer. Transferring to HudsonAlpha, with its supercharged intellectual atmosphere, could be a great career move, but she has mixed feelings about taking advantage of an opportunity created by a tragedy.

With Johnson gone, the department has a large hole to fill in terms of recruiting and mentoring minority students. Davis also supported disadvantaged minority students. These efforts were particularly important in Alabama, where African Americans make up more than a quarter of the population but only 13% of science graduate students.

The president of UAH, David Williams, calls this dimension of the shootings "the saddest thing in so many respects". The biology faculty "was in so many ways a poster child for the diverse scientific department," he says. "That's something that we need to work to preserve and build on."

The last time Hobbs saw Johnson was when he showed her how to draw blood. The next afternoon, just after 3 p.m. on Friday 12 February, Hobbs confronted the rats again, by herself. She quickly succeeded, with all the animals. "I was so happy," she laughs, recalling how she resolved to find Johnson and tell him immediately. But she eventually decided to wait until Monday.

A while later, Hobbs walked out of Johnson's third-floor lab, heading for her office down the corridor, past Conference Room 369R. She ran straight into two black-clad policemen bearing rifles. "I just put my hands up and said 'I work here.' I didn't know what was going on." Hobbs was sent outside, where she waited in the chill air as paramedics emerged with stretchers carrying the wounded. She didn't recognize Monticciolo or Leahy as they were borne past her, beyond the fact that they were people, and that they were grievously wounded. "That's when I knew it was real," Hobbs says.

"If only I could have been there, maybe to have done something."

B. DILL/*NATURE*

Kimberly Hobbs lost her mentor in the shooting.

At the time of the shootings, Leland Cseke was not in the conference room with the other faculty members. As a research assistant professor who is not tenure track and does not normally teach classes, Cseke was not required to attend and Podila had given him the option of bowing out. Cseke had spent much of his adult life working with Podila in one way or another. They met in 1990, when Cseke was an undergraduate at Michigan Technological University in Houghton, and Podila was his adviser. Cseke was drawn by Podila's commitment to using plant molecular biology to tackle environmental issues. In 2002, when Podila was recruited to chair the biology department at UAH, he brought along Cseke, who by then had earned a doctorate and had become Podila's chief lab lieutenant.

Now he is on his own. "I lost my closest colleague," says Cseke, who since the shootings has been trying to do the work of two men. He routinely puts in 13-hour days running the Podila lab, aided by a cadre of students without whom he would be "screwed", he says. He has become faculty adviser for four doctoral students and also oversees two master's students and five undergraduates. In Podila's stead, he is teaching a course in advanced molecular techniques. In addition to his own research, he is working to keep up with the demands of Podila's grants from the Argonne National Laboratory in Illinois and the Energy and Resources Institute in New Delhi, India.

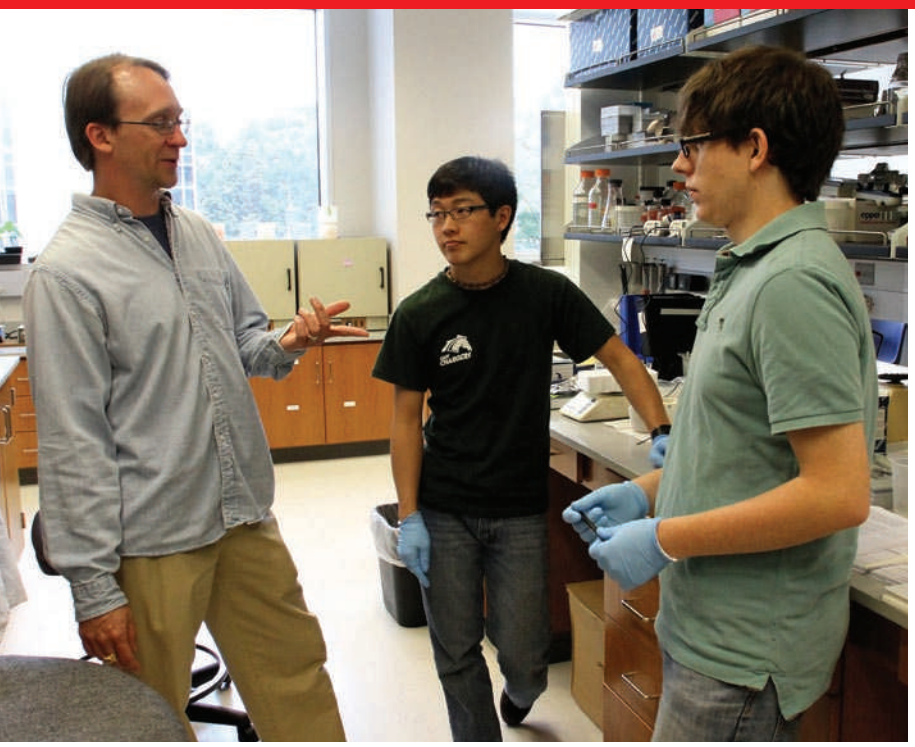
When Cseke gets overwhelmed, he looks at a smiling picture of Podila he has propped up on top of a filing cabinet in his office. He is not sure what will happen in the long run — he knows he can't keep up his current pace indefinitely. Cseke may be considered for one of the tenure-track jobs that has opened up, but that is not a certainty.

Shortly before 4 p.m. on the day of the faculty meeting, Cseke remembers pulling his office door closed and heading towards the lifts to the fourth-floor greenhouse. As he walked down the hall, he saw Amy Bishop coming towards him from the direction of the conference room, "running fast — faster than I have ever seen her".

"She said: 'Hey, Leland,' like nothing had ever happened. She clearly was panicked and I was tempted to ask her if everything was okay. I figured she must be really late to something. So I just let her go."

Cseke went up to the greenhouse and was pondering how to tackle a white-fly infestation when a SWAT team burst through the greenhouse door. They threw him on the floor and frisked him before sending him down the stairs and out of the building.

Over the past few months Cseke has disciplined himself to stop replaying that day in his head. Among the 'what ifs' that tormented him was the fact that he is a seventh-degree black belt in bujinkan budo taijutsu, a traditional Japanese



B. DILL/*NATURE*

Leland Cseke (left) has stepped in to teach and to oversee research grants.

martial art. He wondered if he could have disarmed Bishop, if he had attended the meeting. "If only I could have been there, maybe to have done something," he says. "But eventually I figured out that I just wasn't given that opportunity."

Instead, Cseke continued on his way as Bishop fled from the floor. She later borrowed a phone and called her husband to pick her up. While waiting at the building's loading dock, she was arrested by police.

On 23 March, Bishop appeared in a Huntsville courtroom, handcuffed and dressed in orange prison clothes. During a preliminary hearing, police investigator Charlie Gray testified that police searching the building on 12 February had found a bloodstained woman's jacket and a 9-millimetre pistol in a rubbish bin in the second-floor toilets of the Shelby Center. Gray also testified that Bishop had told police that the shooting hadn't happened, that she had not been present at the meeting and that "it wasn't her". The presiding judge at the preliminary hearing, Ruth Ann Hall, ruled that Bishop should be kept in custody without bail, and that her case should be turned over to a grand jury, which will examine the possibility of indicting her. That process will take months.

Hall also imposed a gagging order on attorneys in the case. Before that, Bishop's lawyer, Roy Miller, had told the media that he will be mounting an insanity defence, but she could plead in a different way if this case moves to trial. In Alabama, capital murder is punishable with life in prison without parole, or with the death penalty.

In late April, a crowd of minority students gathered at a research conference in the Westin Hotel in Huntsville. Normally, the conference would have been overseen by Johnson. Instead, the registration material included a copy of a resolution by the Board of Trustees of the University of Alabama, expressing their deep sorrow at Johnson's loss.

Many of the students are supported by 'Bridge to the Doctorate' awards from the National Science Foundation, the same type of grant that Johnson had helped Hobbs to land six years earlier.

During a break from her duties at the conference, Hobbs says that she has been coping by "keeping myself busy". She has been visiting labs at HudsonAlpha and continuing to work with the diabetic rats in Johnson's lab.

"You go into the building and you are really missing these people."

Now that the initial shock has worn off, a new species of desolation has set in. The once-collegial third floor of the Shelby Center, where she used to enjoy hanging out, has become a lonely place that she leaves as soon as she can. "Every time you are in the building you are thinking about it," she says. "On Fridays, when the clock strikes three or four, you are thinking about it."

Ng is also at the Westin Hotel on this April morning, judging the poster competition and energetically quizzing a freshman nursing student about her work. Ng has been working with his colleagues to develop strategies for moving ahead. They have already posted job vacancies for three visiting professors to start in time for the new academic year in September, and they will soon send out the job announcement for a permanent chairman.

The events of the past few months have refocused him. "Your biggest problems all became minuscule. The things you worry about: getting a manuscript done, the grant proposal that didn't make it. All that stuff just became low priority." After months of avoiding the lab at night, he is starting to work late there again, "accepting that if something happens, it will happen". He has also lost his obsession with collecting news articles about the shootings.

"The adrenaline is gone," he says. But the sadness has moved in. "You go into the building and you are really missing these people."

Moriarty feels much the same. "I told somebody a week ago that I felt worse than I have the whole time," she says. She also sees similar signs in her students. "I have had a number of good students who are not doing well at all now. They come in to me and say, 'I just can't get my mind on it'. I send them all to counsellors."

Moriarty talks to a lot of students. Like her colleagues, she has doubled her advising load and is now mentoring an additional 30 or so undergraduates who had been the charges of Podila, Johnson or Davis. She has also taken on Johnson's mantle as the special adviser for undergraduates bound for the health professions. Moriarty tries to stay focused on the positives. She and colleagues were buoyed when Monticciolo, the staff assistant, was discharged from a local hospital in March. And they all rejoiced when Joe Leahy returned to the department for a visit in late April.

Leahy, who had spent more than two months in hospital, was wearing a helmet covering a spot where his skull had been shattered. Eventually a metal plate will be inserted over the hole. He also had an external jaw brace that was scheduled to be removed three days later. Bishop's last bullet had severed his right optic nerve, blinding his right eye. He had also had lost peripheral vision in his left eye.

Still, says Moriarty, he was "the same old Joe". Students and faculty members clustered around him and he was eagerly planning his return to work.

It was uplifting "just to know that even though he had such a terrible injury, that it hasn't taken him away", says Moriarty. "I was so, so glad to see the amazing progress he has made." ■

Meredith Wadman is a reporter for *Nature* based in Washington DC.