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ANNALS OF MEDICINE

## Conquering the Coma

*What does it take to save the life of a coma patient like the Central Park victim? Not a miracle, as her family and doctor explain.*

by Malcolm Gladwell

1.

On the afternoon of Tuesday, June 4th, a young woman was taken by ambulance from Central Park to New York Hospital, on the Upper East Side. When she arrived in the emergency room, around four o'clock, she was in a coma, and she had no identification. Her head was, in the words of one physician, "the size of a pumpkin." She was bleeding from her nose and her left ear. Her right eye was swollen shut, and the bones above the eye were broken and covered by a black-and-blue bruise.

Within minutes, she was put on a ventilator and then given X-rays and a cat scan. A small hole was drilled in her skull and a slender silicone catheter inserted, to drain cerebral spinal fluid and relieve the pressure steadily building in her brain. At midnight, after that pressure had risen

precipitously, a neurosurgeon removed a blood clot from her right frontal cortex. A few hours later, Urgent Four-as the trauma-unit staff named her, because she was the fourth unidentified trauma patient in the hospital at that time-was wheeled from the operating room to an intensive-care bed overlooking the East River. She had staples in her scalp from the operation, and her chest and arms and fingers were hooked up, via a maze of intravenous lines and cables, to monitors registering heart rate, arterial blood pressure, and blood-oxygen saturation. She had special inflatable cuffs on her legs to prevent the formation of blood clots, and splints on her ankles, since coma patients tend to point their toes. Four days later, after she was identified and her parents and her two sisters arrived at her bedside, one of the first things the family did was to put two large pictures of her on the wall above her bed-one of her holding her niece, and the

other of her laughing and leaning through a doorway-just so people would know what she really looked like.

Urgent Four-or the Central Park victim, as she became known during the spate of media attention that surrounded her case-came close to dying on two occasions. Each time, she fought back. On Wednesday, June 12th, eight days after entering the hospital, she opened one blue eye. The mayor of New York, Rudolph Giuliani, was paying one of his daily visits to her room at the time, and she looked directly at him. Several days later, she began tracking people with her one good eye as they came in and out of her room. She began to frown and smile. On June 19th, the neurosurgeon supervising her care leaned over her bed, pinched her to get her attention, and asked, "Can you open your mouth?" She opened her mouth. He said, "Is your name --?" She

nodded and mouthed her name.

"I'm at the foot of her bed, her cheering squad," her mother recalls. She is a striking woman, with thick black hair and luminous eyes, and her voice grows animated with the memory. " 'Go! Go! You're doing great! Go!' And the doctor says, 'Do you want me to pinch her again?' And I'm yelling at her. I'm telling her, 'Say no, get out of here, go!' "

And her daughter mouthed, "Go."

## 2.

There is something compelling about such stories of medical recovery, and something undeniably moving about a young woman fighting back from the most devastating of injuries. In the days following the Central Park beating, the case assumed national proportions as the police frantically worked to locate Urgent Four's family and identify her attacker. The victim turned out to be a talented musician, a piano teacher beloved by her students. Her alleged assailant turned out to be a strange and deeply disturbed unemployed salesclerk, who veered off into Eastern mysticism during his interrogation by

the police. The story also had a hero, in Jam Ghajar, the man who saved her life: a young and handsome neurosurgeon with an M.D. and a Ph.D., a descendant of Iranian royalty who has an athlete's walk, strong, beautiful hands, and ten medical-device patents to his name. If this were the movies, Ghajar would be played by Andy Garcia.

But the story of Urgent Four is not the standard tale of the triumph of medicine and the human spirit. To think of this as an episode of "E.R." is to diminish it. The typical narratives of recovery are about exceptional people in exceptional circumstances, and that is why the narratives are both irresistible and, finally, less than consoling. Brilliant doctors and new technology can work miracles. But what if your doctor isn't brilliant and your hospital doesn't have the newest technology? If the principal failing of the American medical system is that it provides one standard of care for the fortunate and another for everyone else, the typical story of medical triumph ends up as a kind of indictment, a reminder that miracles are apportioned by privilege and position.

The case of Urgent Four is different. The profession that saved her life is in the midst of an ambitious transformation,

an attempt to insure that you do not have to be ten minutes away from one of the best hospitals in the country in order to survive a vicious beating. One of the leaders of the movement, in fact, is the doctor who saved Urgent Four's life, and he has held up the care she received as an example of what ought to be routine in the treatment of brain injury. That makes the lesson of the Central Park victim and her remarkable recovery exactly the opposite of the lesson of the heroic medical dramas on television. Recovery need not be remarkable. The real medical miracle is the kind that can be repeated over and over again.

## 3.

When Urgent Four was attacked in Central Park, her assailant smashed her forehead on the smooth, hard surface of the sidewalk with such force that the bones above her right eye were shattered. Then, as if he didn't consider his task completed, he turned her over and began again, pounding the back of her head against the ground hard enough to fracture her skull behind her left ear. The ferocity-and the thoroughness-of the attack bruised the muscles between her scalp and her skull, causing her scalp to swell.

What was more serious was that in response to the trauma her brain also began to swell, pressing up against the inside of her skull. In any trauma patient, this swelling, which increases what is known as intracranial pressure (ICP), is the neurosurgeon's chief concern, because the continuing rise in ICP makes it harder and harder for the body to supply the brain with an adequate amount of blood. Upon autopsy, ninety per cent of coma patients show clear signs of stroke: their brains quite literally starved to death.

This is why when Urgent Four was brought to the New York Hospital-Cornell Medical Center complex the neurosurgical resident on duty inserted a catheter through her skull to siphon off excess cerebral spinal fluid. In cases of trauma, this clear fluid, in which the brain floats, flows into a cavity that is called the ventricle, in the center of the brain, and the hope was to empty the ventricle, reducing the pressure inside the skull. This is also why the trauma staff kept a very close eye on the pressure gauge attached to that catheter during the first few hours after Urgent Four was admitted. According to the index used by neurologists, a healthy person's ICP is between zero and ten.

Urgent Four's was at twenty, which is high but not disastrous. A further rise, however, would put her in the danger zone. At nine o'clock Tuesday night, that is exactly what happened: Urgent Four's ICP abruptly surged into the fifties.

The physician in charge of her case, Jam Ghajar, is, at forty-four, one of the country's leading neurotrauma specialists. On his father's side, he is descended from the family that ruled Persia from the late seventeen-hundreds until 1925, and his grandfather on his mother's side was the Shah of Iran's personal physician. Neurosurgeons, Ghajar says, with a smile, are "overachievers," and the description fits him perfectly. As a seventeen-year-old, he was a volunteer at U.C.L.A.'s Brain Research Institute. As a first-year resident at New York Hospital, he invented a device--a tiny tripod to guide the insertion of ventricular catheters--that made the cover of the Journal of Neurosurgery. Today, Ghajar is the chief of neurosurgery at Jamaica Hospital, in Queens. He is also the president of the Aitken Neuroscience Institute, in Manhattan, a research group that grew out of the double tragedy experienced by the children of Sunny von Bülow, who lost not only their mother to coma but also their father, Prince Alfred von

Auersperg, after a car accident, thirteen years ago. Most days, Ghajar drives back and forth between the hospital and the institute, juggling his research at Aitken with a clinical schedule that keeps him on call two weeks out of every four. "Jam is completely committed--he's got a razor-sharp focus," Sunny von Bülow's daughter, Ala Isham, told me. "He's godfather to my son. I always joke that we should carry little cards in our wallets saying that if anything happens to us call Jam Ghajar."

Ghajar spent all day Tuesday, June 4th, at Jamaica Hospital. In the evening, he returned to the Aitken Neuroscience Institute, where a colleague, Michael Lavyne, told him of the young woman hovering near death across the street at New York Hospital. At seven o'clock, Ghajar left his office for the hospital. Two hours later, with Urgent Four's ICP at dangerous levels, he ordered a second cat scan, which immediately identified the culprit: the bruise on her right frontal cortex had given rise to a massive clot. At midnight, Ghajar drilled a small hole in her skull, cut out a chunk three inches in diameter with a zip saw, and, he said, "this big brain hemorrhage

just came out-plop-like a big piece of black jelly."

But the task was only half finished. The rule of thumb for a trauma patient is that the blood pressure has to be kept at least seventy points higher than the ICP or the flow of oxygen and nutrients to the brain will be impaired. Even after Urgent Four's clot was removed, her differential was only fifty points. At the same time, however, her heart was racing at a hundred and eighty beats per minute. This made raising her blood pressure tricky. "We're standing around her bed," Ghajar recalls. "It's four in the morning. There's Dr. Fischer"-Eva Fischer, the group-care physician-"there's three surgical residents, there's myself, there's a chief resident from neurosurgery, and then two nurses, and we're all standing around her trying to figure out what the best drug would be to reduce her pulse and increase her blood pressure at the same time." It took three hours-and two different blood-pressure medicines-to get Urgent Four out of the danger zone. It was 7 a.m. when Ghajar left her bedside and began neurosurgery rounds.

#### 4.

The identity of Urgent Four did not become known until

the next day, Thursday. By a series of flukes, no one in her family had even suspected that she was missing. Her older sister, whom I will call Jane, had been with her the previous Saturday night, when she played in a concert. The two sisters, who share a birthday, spoke on the phone on Monday afternoon, and it wasn't unusual for several days to pass between conversations. Nor did the news of the attack, when it became public, make much of an impression on Jane: her car radio was broken, and, because she was busy with work, she had no time to read the newspaper. Her parents, meanwhile, were travelling in Utah, and were equally oblivious. "It was the first vacation we'd ever taken where we hadn't read a newspaper," her mother told me. "Or watched the news."

On Thursday, however, one of Urgent Four's piano students showed up for her weekly lesson, and when her teacher didn't arrive the student remembered seeing drawings of the Central Park victim that had been posted on buildings and mailboxes throughout Manhattan, and she began to wonder. She called the police. They searched the woman's apartment, on Fifty-seventh Street, and learned her parents' address, in New Jersey. Upon finding that they were away, the police telephoned Jane, at her home,

also in New Jersey, using as a guide the return address on a letter Jane had written to her sister. It was one-thirty Friday morning.

"I got a call from the police, which I didn't believe, of course," Jane said. She is a graceful woman, with shoulder-length black hair and a hint of a Jersey accent. "I thought it was a prank call, and I thought I was being stalked. They asked me my name and if I had a sister with that name, and I was almost rude to them on the phone, because I thought it was someone playing a joke on me. Then they referred to this incident, and I had no idea what they were talking about. At that point, my husband ran and got the newspaper, because he had been following the story and had seen the sketch. I got off the phone and had to fight collapsing. The captain probably sensed that. He said, 'Can you come? I'll send you an escort.' And then he called back a little while later and said, 'Would you be willing to ride in a helicopter to get here?'"

At 3 a.m., she and her husband landed in Manhattan. They were taken immediately by police car to the hospital, and there they were greeted by Mayor Giuliani and Howard Safir, the police commissioner.

"They probably spent twenty minutes trying to let me understand what had happened and prepare me, and I ended up saying, 'Don't bother trying to prepare me. It's not going to work.' The anticipation was awful. And when I saw her, of course, the effect was indescribable."

The next to arrive was the family's youngest daughter, who came by car with her husband later on Friday morning. At midnight Friday, the parents arrived. The police had tracked them down by tracing their rental-car registration and then sending the Utah police cruising through motel parking lots in and around Zion National Park to spot the corresponding license plate. "At one point after they found us," her father told me, "we drove through a town in Utah which had my mother's name. Both of us burst out crying. My mother was pretty close to her. So we took that as an omen that she would be looking over her." Jane said that when she first saw the patient at the hospital she knew immediately she was her sister. But her father said that if he had not been told who she was he would never have known her. "To me she was almost unrecognizable," he said.

I met with Urgent Four's family—her mother, father, and older sister—in Jam Ghajar's office, on East Seventy-second Street, two days after she first began to speak. Her parents have been together for thirty-eight years, and have the easy affection of the well-married. The father, trim and gray-haired, is an engineer by training, with the discipline and plain-spokenness characteristic of that profession. His wife is a schoolteacher, intelligent and articulate. They spoke with me on the condition that the personal details of their lives be kept private, and they confined their conversation to details of the case which they considered germane: their religious faith, their admiration for Dr. Ghajar's medical team, their hopes for their daughter's recovery. It was an intense and moving conversation. Over the past three weeks, the family has fashioned a protective cocoon for themselves, refusing to read any of the press accounts of Urgent Four's assailant, and barely leaving her hospital room except to rest and eat. This was the first time they had talked to the outside world, and long-pent-up feelings and thoughts came out in a rush.

"We went for days on two hours' sleep," her mother said. "You don't feel as tired, because you're so wound up. You want it all to be over. You

want to wake up and know it's over—and it's not." The mother seemed the most shaken and most exhausted of the three. At one point as we talked, she accidentally referred to her daughter in the past tense, saying, "She was—"

"Is," Jane interrupted. "Is."

## 5.

Had Urgent Four been taken to a smaller hospital, or to any of the thousands of trauma centers in America which do not specialize in brain injuries, the chances are that she would have been dead by the time any of her family arrived. This is what trauma experts who are familiar with the case believe, and, of the many lessons of the Central Park beating, it is the one that is hardest to understand. It's not, after all, as if Urgent Four were suffering from a rare and difficult brain tumor. Brain trauma is the leading cause of death due to injury for Americans under forty-five, and results in the death of some sixty thousand people every year. Nor is it as if Urgent Four had been given some kind of daring experimental therapy, available only at the most exclusive research hospitals. The insertion of the ventricular catheter is something that all neurosurgeons are taught to

do in their first year of residency. CAT scanners are in every hospital. The removal of Urgent Four's blood clots was straightforward neurosurgery. The raising and monitoring of blood pressure are taught in Nursing 101. Urgent Four was treated according to standards and protocols that have been discussed in the medical literature, outlined at conferences, and backed by every expert in the field.

Yet the fact is that if she had been taken to a smaller hospital or to any one of the thousands of trauma centers in America which do not specialize in brain injuries she would have been treated very differently. When Ghajar and five other researchers surveyed the country's trauma centers five years ago, they found that seventy-nine per cent of the coma patients were routinely given steroids, despite the fact that steroids have been shown repeatedly to be of no use-and possibly of some harm-in reducing intracranial pressure. Ninety-five per cent of the centers surveyed were relying as well on hyperventilation, in which a patient is made to breathe more rapidly to reduce swelling-a technique that specialists like Ghajar will use only as a last resort. Prolonged hyperventilation

does reduce ICP, but it can also end up reducing the flow of blood to the brain, causing irreversible brain damage. The most troubling finding, however, was that only a third of the trauma centers surveyed said that they routinely monitored ICP at all. In another hospital, the surge in Urgent Four's ICP on Tuesday night which signalled the formation of a blood clot might not have been caught.

Such dramatic variations in medical practice are hardly confined to neurosurgery. It is not unusual for doctors in one community to perform hysterectomies, say, at two or three times the rate of doctors in another town. Rates for some cardiac procedures differ around the country by as much as fifty per cent. Obstetrical specialists are almost twice as likely to deliver children by cesarean section as family physicians are. In one classic study published seven years ago, a team of researchers found that children in Boston were 3.8 times as likely to be hospitalized for asthma as children in Rochester, New York; 6.1 times as likely to be hospitalized for accidental poisoning; and 2.6 times as likely to be hospitalized for head injury.

In most cases, however, the concern about practice variation has focussed on the issue of cost. The point of the

Boston-Rochester study was not that the children of Boston were receiving considerably better care than their counterparts in upstate New York but, rather, that health care for children in Boston might well be needlessly expensive. When it comes to brain injury, the stakes are a little higher. At the handful of centers around the country specializing in brain trauma, it is now not unusual for the mortality rates of coma patients to run in the range of twenty per cent or less. At trauma centers where brain injury is not a specialty, mortality rates for coma patients are often twice that. "If I break my leg, I don't care where I go," Randall Chesnut, a trauma specialist at San Francisco General Hospital, told me. "But, if I hit my head, I want to choose my hospital."

Part of the problem is that in the field of neurosurgery it has been difficult to reach hard, scientific conclusions about procedures and treatments. Physicians in the field have long assumed, for example, that blood clots in the brain should be removed as soon as possible. But how could that assumption ever be scientifically verified? Who would ever agree to let a comatose family member lie still with a mass of congealed blood in the brain

while a team of curious researchers watched to see what happened? The complexity and mystery of the brain has, moreover, led to a culture that rewards intuition, and has thus convinced each neurosurgeon that his own experience is as valid as anyone else's. Worse, brain injury is an area that is of no more than passing interest to many neurosurgeons. Most neurosurgeons make their living doing disk surgery and removing brain tumors. Trauma is an afterthought. It doesn't pay particularly well, because many car-accident and shooting victims don't have insurance. (Urgent Four herself was without insurance, and a public collection has been made to help defray her medical expenses.) Nor does it pose the kind of surgical challenge that, say, an aneurysm or a tumor does. "It's something like-well, you've got mashed-up brains, and someone got hit by a car, and it's not really very interesting," Ghajar says. "But brain tumors are kind of interesting. What's happening with the DNA? Why does a tumor develop?"

Then, there are the hours, long and unpredictable, tied to the rhythms of street thugs and drunk drivers. Ghajar, for example, routinely works through the

night. He practices primarily out of Jamaica Hospital, not the far more prestigious New York Hospital, because Jamaica gets serious brain-trauma cases every second day and New York might get one only every second week. "If I were operating and doing disks and brain tumors, I'd be making ten times as much," he says. In the entire country, there are probably no more than two dozen neurosurgeons who, like Ghajar, exclusively focus on researching and treating brain trauma.

Ghajar says that in talking to other neurosurgeons he sensed a certain resignation in treating brain injury—a feeling that the prognosis facing coma patients was so poor that the neurosurgeon's role was limited. "It wasn't that the neurosurgeons were lazy," Ghajar said. "It was just that there was so much information out there that it was confusing. When they got young people in comas, half of the patients would die. And the half that lived would be severely disabled, so the neurosurgeon is saying, 'What am I doing for these people? Am I saving vegetables?' And that was honestly the feeling that neurosurgeons had, because the methods they were trained in and were using would produce that kind of result."

Three years ago, after a neurosurgery meeting in Vancouver, Ghajar—along with Randall Chesnut and Donald W. Marion, a brain-trauma specialist at the University of Pittsburgh—decided to act. For help they turned to the Brain Trauma Foundation, which is the education arm of the brain-trauma institute started by Sunny von Bülow's children. The foundation gathered some of the world's top brain-injury specialists together for eleven meetings between the winter of 1994 and last summer. Four thousand scientific papers covering fourteen aspects of brain-injury management were reviewed. Peter C. Quinn, the executive director of the Brain Trauma Foundation, who coordinated the effort, says, "Sometimes I felt I was in a courtroom drama, because what they did was argue the evidence of the scientific documents, and as soon as someone said, 'It's been my experience,' everyone would say, 'Oh, no, that won't cut it. We want to know what the evidence is.' They would come in on a Friday and work all day Saturday and Sunday. They'd work a twenty-hour weekend. It was gruelling."

In March of this year, the group produced a book—a blue three-ring binder with fifteen bright-colored

chapter tabs-laying out the scientific evidence and state-of-the-art treatment in every phase of brain-trauma care. The guidelines represent the first successful attempt by the neurosurgery community to come up with a standard treatment protocol, and if they are adopted by anything close to a majority of the country's trauma centers they could save more than ten thousand lives a year. A copy has now been sent to every neurosurgeon in the country. The Brain Trauma Foundation has mailed the guidelines to scientific journals, hospitals, managed-care groups, and insurance companies, and the neurosurgeons involved with the project have been promoting their work at medical meetings around the country. This is why the story of the Central Park victim does not end the way most medical dramas end, in empty celebration of heroics and exceptionalism, but instead has become a powerful symbol of the campaign to reform neurosurgery. For everything Jam Ghajar used to save Urgent Four's life is in that binder.

"What we are hoping is that if a woman gets hurt in the middle of rural Wyoming, and there is a neurosurgeon there and a hospital with an I.C.U., then she will have as

good a chance to survive as she would in the middle of New York City," I was told by Jack Wilberger, Jr., who is an associate professor of neurosurgery at the University of Pittsburgh Medical Center and a member of the guidelines team. "That's what we're hoping for. To give everyone the same chance, to give a everyone a level playing field."

## 6.

Urgent Four had one more scare before she began her climb toward recovery. Late Sunday night, her ICP began to rise again, back up into the thirties. Ghajar, who was in Paris meeting with the World Health Organization about the brain- trauma guidelines and was calling in to the hospital residents for updates, began to get worried. He booked a flight home. While he was in the air, Urgent Four's condition worsened. A third cat scan was ordered, and it showed that she had developed a second clot-this time on her left temporal lobe, in the place behind her ear where her attacker had banged the back of her head. This clot was far more serious than the first, because the temporal lobe is the seat of comprehension, and to remove the clot might well risk damaging Urgent Four's ability both to speak and to understand. "At about twelve-thirty, quarter to one on

Monday, there was a pounding on the door of our room," the patient's father said. "We were wanted back on the floor, and we had to make a decision within a very few minutes on whether they should operate. What we were given was: If you don't operate, she might die. The other side of it was that if they did operate it could save her life but with a decent likelihood that she might be very badly impaired. So we and our two daughters went back and thrashed it out and we unanimously decided to go forward."

It was by then one-thirty in the morning. For four hours, the family waited, sleepless and exhausted, terrified that they had made the wrong decision. At dawn, the surgeon filling in for Ghajar, Michael Lavyne, emerged from the operating room. A miracle had happened, he reported: as soon as an incision was made, the clot had just popped out, all on its own. "They got lucky," Ghajar says.

From that point, Urgent Four's progress was steady. Her eye opened. Then she began to talk. The swelling around her face receded. Her ICP became normal. Soon she was sitting up. By last week, she was working with a speech therapist, and Ghajar and her father had

begun driving around the New York area looking for a good rehabilitation center.

"Yesterday, she was looking at me, and I said, 'You know, you had a bad accident, and your brain was bruised'-I'd told everyone not to tell her she was assaulted. 'Your brain was bruised, and you are recovering.' She looked at me and she frowned. Her eye went up with this 'Oh, really?' look. And I said, 'Do you remember your accident?' She shook her head. But it's too early. Sometimes they do." Ghajar went on, "We are very good at predicting outcome, in the sense of mortality, but we're not good at predicting functional outcome, which is the constant question for this patient. 'Is she going to be able to play the piano?' We still can't answer that question."

In his first week back on call after the Urgent Four case, Ghajar saw three new coma patients. The latest was a thirty-year-old man who had barely survived a serious car accident. He was in worse shape than Urgent Four had been, with a hemorrhage on top of his brain. He was admitted to Jamaica Hospital on Monday at 11 p.m., and Ghajar operated from midnight to 6 a.m. He inserted a catheter in the patient's skull to drain the

spinal fluid and monitored his blood pressure, to make sure it was seventy points higher than his ICP. Then, that evening-fourteen hours later-the patient's condition worsened. "I had to go back in and take out the hemorrhages," Ghajar said, and there was a note of exhaustion in his voice. He left the hospital at one o'clock Wednesday morning.

"People want to personalize this," Ghajar said. He was on Seventy-second Street, outside his office, walking back to New York Hospital to visit Urgent Four. "I guess that's human nature. They want to say, 'It's Dr. Ghajar's protocol. He's a wonderful doctor.' But that's not it. These are standards developed according to the best available science. These are standards that everyone can use."

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