

Chapter One

NEUROSCIENCE: The Runner's Brain

MORGUES ARE SPOOKY PLACES at the best of times. Even during the day, when knots of chattering medical students gather round the brightly-lit dissecting tables and senior pathologists poke at ruptured aortas or cancer-ravaged livers, they offer uncomfortable reminders of our own mortality. Not just the sight of the dead and the disorders that killed them, but also the odour – if not the odour of death itself, then the acrid fumes of formalin, the preservative that keeps death's putrefaction at bay.

At night, it's worse. And it was night – the middle of the night – as Rebecca Folkerth stood next to a table in the morgue at the New England Medical Center, Tufts University's teaching hospital on Tremont Street in downtown Boston. It was on a weekend in the late winter of 1991. Bundled against the cold, a few late-night revellers were still strolling the streets outside, looking for all-night Chinese restaurants or checking out the attractions of the Combat Zone, Boston's always-open red-light district. But inside the morgue, all was quiet, and Folkerth was alone.

Well, not quite alone. For company she had 53-year-old Max Truex, whose brain she was removing.

When Science Goes Wrong

Folkerth was a pathologist, but not a senior one. In fact, the blonde 32-year-old had just taken her boards – the examination that qualified her in the sub-speciality of neuropathology – a few months earlier. She hadn't yet accumulated the portfolio of macabre experiences that make pathologists such entertaining dinner guests, but this night would get her off to a good start. As she looked at Truex's brain, she blinked, looked again, and said to herself, 'What the *hell* is this? This is *creepy*!'

Max Truex was born in Warsaw, Indiana, in 1935. His father, Russell, was a locomotive engineer with the Pennsylvania Railroad. Although he drank too much, Russell was a good family man and a reliable provider for his wife, Lucile, and their three sons, Gene, Max, and Don.

Gene was four years older than Max, so there was always a certain distance, an unquestioned division of authority and obedience, between them. With Don it was different. Don was born only a year-and-a-half after Max. What was worse, Max grew slowly, so already by the time he was six Don had caught up with him in stature. When I visited Don in 2005 – he's now in his late sixties, a practising dentist in Santa Barbara, California, and a running, cycling, and general fitness enthusiast – he told me that the height issue was a major factor in their relationship. 'It was a real sore point for him,' he said. 'When we were youngsters, it was a fight every day. Our next-door neighbour said she thought we would never grow up, because one of us was going to kill the other.'

But it wasn't either Max or Don who failed to grow up – it was their older brother, Gene. When he was 16, and the younger boys were 12 and 11, the three of them were driving in the family car, with Gene at the wheel. At an intersection they collided with a dump truck, and Gene was killed.

After this tragedy, Max found himself suddenly and unexpectedly in the role of eldest son, yet with a younger brother who was now several inches taller than he was. What saved the two boys from mutual destruction was sports. Gene, before his death, had already been running the mile in high school, and now the two younger boys followed his lead, taking to running and other sports with fierce dedication and competitiveness. And in the process they became good friends.

Although there are exceptions, taller runners usually excel at sprinting, while smaller runners do better in endurance events. At a final height of 5ft 5in, and a weight of 9st 3lb, Max Truex was very similar in stature to Ethiopians like Haile Gebrselassie, who utterly dominated world competition at 10,000 metres during the 1990s, or Kenenisa Bekele, the current world record-holder at that distance. But back in 1950, no one had set eyes on an Ethiopian runner, so Max's modest size drew people's attention. It encouraged them to develop an affectionate or protective attitude toward him, as if they saw him as a permanent child.

There were other traits that had the same effect. Although the Truexes are French in ancestry, Max had a broad, Slavic-looking face that seemed to carry a fixed, somewhat childish smile, even when he was running. And as he ran, he 'skipped' – he would frequently and erratically switch his stride, as if out of sheer playfulness. Indeed, he was naturally good-humoured. For all these reasons, people called him Maxie and liked to take him under their wing. Later, when newspapers started recording his feats, they would refer to him with patronising titles like 'The Little Strider.' They described him as 'spunky', as if his small stature was a natural handicap that only grit and determination had overcome.

In high school, Max Truex was a star athlete – he won the state cross-country championship and set a national interscholastic record for the mile. On account of his performances Truex was actively recruited by several universities, and he finally accepted a track scholarship at the University of Southern California, where he was drawn by the warm climate and the school's high ranking in athletics.

One of the people who was involved in recruiting him was USC's assistant track coach, Jim Slosson, who became a lifelong advisor and friend to Truex. Under Slosson's tutelage, Truex quickly came to focus on the long-distance events – the 5,000 and 10,000 metres – where his remarkable powers of endurance counted the most.

Success came quickly. In June of 1956, at the age of 20, Truex won the 10,000 metres at the US Olympic trials, thus guaranteeing him a berth on the Olympic team. In October of that year, one month before the Games, he set his first US national record, in the 5,000 metres. (He was to set four more records in that event over the

When Science Goes Wrong

following six years.) Unfortunately, he suffered a muscle injury shortly before leaving for the Olympics, which were held in Melbourne, Australia; he competed in the 10K but did not do well.

At USC, Truex was a member of the Air Force Reserve Officers Training Corps, so in 1958, after graduating, he joined the Air Force and served for four years as an officer at Oxnard Air Force Base in California. This base was a hotbed of athletic activity – the athletes were given all the time they needed to train and compete. In 1959, Truex set a new US indoor record in the two-mile event. Then, in the following year, he was the highest-placed American in the 10,000 metres race at the US Olympic trials, again guaranteeing himself a place on the Olympic team.

The 10K race at the Rome Olympics, in September of 1960, was probably the high point of Truex's running career. He didn't win – in fact, he only finished sixth – but his time of 28 minutes and 50.34 seconds took eight seconds off the existing US record and was a performance which put the United States on the distance-running map for the first time. Just a week after the Rome Olympics, Truex iced the cake by setting a new US record in the 3,000 metres.

Truex quit competitive athletics in 1962, when he left the Air Force and entered law school at USC. He didn't quit running, however. He ran all through his three years at law school, and he ran while he was working as an attorney, first in private practice in Orange County and then in the legal office of the County of Los Angeles. He lived in an apartment near Universal Studios: during that period he ran five, six, or seven miles daily along a footpath next to the Hollywood Freeway. He didn't need the spur of competition, he just loved running and the sense of fitness that went with it.

'I told him I thought it was unhealthy to run along the freeway,' Jim Slosson told me in a 2005 interview, and indeed it must have been. Los Angeles at that time had some of the worst air pollution in the country. Truex was breathing in a truly evil brew of toxins, including carbon monoxide, particulates, ozone, and lead from automobiles on the freeway, as well as industrial chemicals such as the pesticide DDT, which was being manufactured with carefree abandon by the Montrose Chemical Corporation at its plant on Normandie Avenue. Although now banned, residues of the wind-born DDT dust can still be found in soils miles from the plant.

Even during Truex's competitive career, there were several occasions when his running had caused him acute health problems. He had to drop out of at least three races on account of exhaustion caused by some combination of excessive heat and air pollution. The worst occasion was in 1961, while he was competing in the Corrida de São Silvestre, a traditional 15-kilometre race that is held every New Year's Eve in São Paulo, Brazil. Although the race took place at night, it was oppressively hot and humid. Truex was in the lead, immediately behind a phalanx of motorcycles and television trucks that belched the combustion products of cheap South American gasoline. He suddenly collapsed, and the next thing he knew he was in the hospital, hooked up to an IV but losing fluids faster than they could be pumped in. By the time he got on a plane back to the United States, he was fifteen pounds lighter than when he set out.

In spite of his chronic exposure to pollutants and heat stress, Truex remained in apparent good health during his early professional years. He enjoyed his work as an attorney, often appearing in court to argue real-estate and land-use cases on behalf of the county. And in 1973 he married.

I recently met Truex's widow, Kay Truex De Justo, in Fresno, California, where she lives with her present husband, Michael De Justo. She is in her late 50s, a trim-looking, well-preserved brunette with a precise, no-nonsense style of speech that may reflect her educational experience – she was in graduate school in English at both USC and Massachusetts' Brandeis University, although circumstances prevented her from obtaining a doctorate at either institution.

Kay told me that at the time she met Max in the summer of 1973, she was working as a teacher in Fresno, California, the city where she was born, but sometimes came down to Los Angeles to visit one of her brothers. On these visits she occasionally dated a colleague of Max's, but it didn't work out, and that colleague – whether out of kindness or in order to speed the end of the relationship – set up a blind date for her and Max. Although Max was 11 years older than she – he was 37, and she was 26 – the two hit it off right away. Within a few weeks, they went on a backpacking trip together in the eastern Sierras, and within four months they had married.

When Science Goes Wrong

Kay loved Max's outgoing, light-hearted approach to life and his active lifestyle. Besides backpacking, he introduced her to skiing, which took them to Heavenly Valley at Lake Tahoe, among other locations. Max also continued to run; soon after they married they bought a house in the Hollywood Hills, so Max was able to run in Griffith Park, a slightly healthier environment than the Hollywood Freeway.

Children were quick in coming: Gene, their eldest son (no doubt named for Max's older brother) was conceived on their honeymoon and born in August of 1974, and their second son, John, was born two years later. A few months before John was born they moved to a new home in Manhattan Beach.

One evening in early 1979 when Kay was preparing dinner, she looked through the kitchen window and saw Max walking in from the garage as usual – but he was dragging one of his feet as he walked. Kay didn't think much of it; she knew that Max had injured that foot sometime during his running career. But it kept on happening, and after a few weeks it became his regular style of walking. Then she noticed something else: when she kissed Max goodbye in the morning, she saw that he had failed to shave a small part of his face, up by one ear. Max himself noticed problems. He had trouble raising his arms to wash his hair in the shower, and he also had voice problems. On one occasion when he was on his lunch break, he saw an old friend across the street and tried to shout his name but no sound came out of his throat. These symptoms alarmed him, but he said nothing to Kay about them at the time and he minimised the significance of the symptoms that she herself had noticed.

A few months later, one of Max's hands began to shake – a steady tremor that showed itself most when his arm was at rest. One of Max's legal colleagues noticed the tremor and recommended that Max go see a doctor. He did so, and as a result Max was admitted to Encino Hospital. 'They ran all manner of tests on him,' said Kay, 'and on Thursday of that week they told us that it was Parkinson's disease.'

At the time he was diagnosed, Max didn't know much about Parkinson's disease, but Kay was well aware that it was a progressive and potentially fatal disorder of movement. 'There had been a man

in our church who had had it,' she said. 'You could just see him diminish. I knew it was very serious.'

The central biological process that causes the symptoms of Parkinson's disease is thought to be the death of a set of brain cells that produce a neurotransmitter, or signalling molecule, called dopamine. These cells are located in a small region of the brainstem called the *substantia nigra* or 'black substance' – so-called because these cells are heavily pigmented. The cells have extensions called axons that run from the *substantia nigra* to the striatum, a structure higher up in the brain that helps to generate body movements. (More accurately, there are two striatums, one in the left and one in the right hemisphere of the brain.) The tips of the axons – the synapses – release dopamine into the striatum, and this release is vital for normal function.

In Parkinson's disease, the cells of the *substantia nigra* gradually die over a period of years or decades, and their axons die too, so the striatum is gradually starved of its supply of dopamine. Well over half of the dopamine cells have to die before the disease shows itself, however: thus, a person who experiences symptoms for the first time has actually harboured the underlying disease process for years without knowing it.

Of course, people who develop Parkinson's disease want to know why *they* got the disease rather than someone else. In most cases, the answer isn't known. Doctors commonly describe the disorder as 'idiopathic', meaning that it seems to develop of its own accord without any obvious external cause. Still, there are some clues. In particular, chronic exposure to pesticides, herbicides, and other environmental pollutants raises the likelihood of developing the disease. What's more, some people have a genetic makeup that makes it hard for the body to break these pollutants down, and this makes such people more likely to develop Parkinson's disease if they are chronically exposed to pollutants.

Truex might have been exposed to agricultural pollutants during his childhood, when he lived in a farming area, drank well water and ate fish caught by his father in a polluted lake. Also, as mentioned earlier, Truex was exposed to a variety of toxic agents in his adult life as a result of training and racing in highly polluted air. Still, it will never be known for sure whether these exposures were a factor in his

When Science Goes Wrong

developing Parkinson's disease, or whether his case was truly 'idiopathic.'

The mainstay of treatment for Parkinson's disease is the drug L-dopa. Once ingested, this drug enters the brain, where it is transformed into dopamine and thus makes up for the brain's own deficient supply. It is usually taken in a proprietary form called Sinemet, in which the L-dopa is combined with another drug that protects the body from some of L-dopa's potentially harmful side-effects. Truex did take Sinemet, and it helped him, but it did not prevent the progression of his disease. In particular, his speech began to be affected. He spoke too rapidly: when he was speaking in court, the court reporter would ask him to slow down, but somehow he couldn't. Then his voice weakened, so that it was hard to hear him in any kind of noisy environment, and he also began to slur his words. Max's brother Don told me that he took Max to task for 'mumbling' – he didn't realise that it was a symptom of his disease. 'I said, "Max, you earn your living talking, you've got to talk so that you can be heard."'

In spite of these problems, family life went on in a reasonably normal fashion. About six months after Max was diagnosed, their daughter, Mindy, was born. Max did as much as he could to help with the children. And he even kept on running. He now knew that his disease was likely to progress, but he focused on the hope of remaining an effective father and provider for as long as the children needed him.

Unfortunately, within two years or so, his voice deteriorated to the point that he could no longer function effectively in court. Truex wanted to continue working by concentrating on office work, but the county thought otherwise: they retired him on a disability pension. The pension was adequate to maintain the family's standard of living, but the sudden termination of his career was a brutal experience for an active man like Truex. He worked for a few months in the office of a colleague, then quit working entirely.

Gradually, the disease started to close in on him. He began to have problems driving, especially when he needed to make rapid turns of the steering wheel. He had always looked forward to being an active role model to his children, taking them backpacking and skiing, teaching them athletics and so on, but all these things became

harder and harder. His doctor frequently increased the dosage of his drugs or added new ones, but they never quite kept up with the advancing disease. Max's walking became stiff and slow, and getting up from a chair required a great effort. He had to give up running – a terrible blow.

The Truexes thought that living in Los Angeles might be too demanding for Max, and they decided to move somewhere with a slower pace of life where he might be able to continue with activities such as driving. At the urging of an old Air Force team-mate who lived in Gunnison, Colorado, they moved to that city. Both Max and Kay liked Gunnison. ('It was like being on vacation,' says Kay.) But the move did nothing to slow the advance of Max's disease. He began to experience episodes of 'freezing', when he simply got stuck in the middle of what he was doing and couldn't move at all. His walking became unsteady to the point that he was in constant danger of falling. The tremor in his arms worsened. And after he got into two car accidents in the space of two days, he had to give up driving for good.

Max remained under the care of his doctor in California, who juggled Max's drugs as best he could. He was taking about 30 tablets a day, some of them intended to treat the disease, and some to counteract those drugs' side-effects. As often happens with people with Parkinson's disease, it became unclear which of his drugs were helping him and which were harming him, and so his doctor decided to take him off all his drugs for a couple of weeks so that he could be 're-levelled'. The idea was to reintroduce the drugs one by one, while observing what effects they had. During the time that Max went without the drugs he stayed with Don in Santa Barbara, so Don got to see the full extent of Max's disease in its untreated state. 'He came unglued,' Don told me. 'He couldn't do anything. He couldn't even swallow.'

The re-levelling may have led to some temporary improvement, but Max soon began to go downhill again. By the mid-1980s, he was having trouble with dressing, cutting up his food, and any other task that required delicate control of movement. His symptoms seemed to change from day to day. 'If I was paralysed from the waist down,' Kay remembers him saying, 'I would know what I could do and what I couldn't do, but with this I never know whether it's going to affect

When Science Goes Wrong

my ability to walk, my ability to speak, whether I'm going to shake or not shake, I never know which part of my body is going to go.'

Max struggled on. As his sons got to the same age as he was when he started running, so did they. Max tried to coach them, but often Kay had to help out. Max's friends from his college and Air Force days rallied round. Kay recounts how one friend insisted on taking Max and his family to Vail for a skiing vacation: 'He said, "I don't care how many times you fall, Max, I'll pick you up." And he did.'

Toward the end of the 1980s, when Max had been battling Parkinson's disease for nearly a decade, things began to get rapidly worse. As so often happens with L-dopa treatment, the drug had begun to lose some of its effectiveness, and even with the addition of other drugs he was in a serious plight. Now Kay had not only to cut up his food but to lift it to his mouth, too. And his swallowing was impaired almost as severely as when he had been off the drugs entirely: he would choke on his food as often as he swallowed it. Max became quite depressed and anxious about his future.

One person who followed this decline with great concern was his old track coach, Jim Slosson. When Slosson met Max in 1988, he was devastated to see how this brilliant athlete had been reduced to a shuffling invalid. A little later, Slosson was having dinner with one of his own old track buddies, a half-miler by the name of Paul Iacono, and he told Iacono about Max's illness. As it happened, Paul had a son, Robert, who was a 36-year-old neurosurgeon with a special interest in Parkinson's disease, so Paul arranged for Max to meet him.

I visited Dr Iacono in the year 2000 at his office in Redlands, California. He was a handsome and still young-looking man with black hair and a full, black moustache. He certainly looked to be of Italian descent, as his name suggested. What was most memorable about him, though, was not his appearance but his manner of speech. He was unstoppable, and often very colourful in his choice of words. He seemed perpetually on the brink of saying more than would be wise. An interview that I expected to last for less than an hour went on for three hours, during which time I barely had the opportunity to get in a few questions. Various assistants and medical students drifted in or drifted out during our meeting, as if to get samples of their boss's oratory.

Back in 1988, Iacono was based at the University of Arizona Health Sciences Center and the Veterans Administration Hospital, both located in Tucson. He had gone to college and medical school at USC, and he had done further training at Duke University where he had developed a special interest in the underlying mechanism of Parkinson's disease. 'I was mostly grinding on new theory,' he told me. 'I wrote a couple of hundred papers when I was at the University of Arizona on neurobiological theory because I was trying to pave a new trail into the unmarked stuff. Because the marked stuff, the dogma, is just crap when it comes to Parkinson's disease.'

If Iacono did write that number of papers, most of them must have remained unpublished or else they were published in minor periodicals that are overlooked by the indexing services. But those that are available do attest to his iconoclastic approach to neurology during that period: they suggested novel causes and novel treatments for a number of disorders. In a paper published in 1990, for example, he suggested that a cluster of brain cells named the *locus coeruleus* played an important role in the development of Parkinson's disease. The neurotransmitter used by those cells is not dopamine but a related compound named norepinephrine (also called noradrenaline – it's a close chemical relative of adrenaline). If true, Iacono's hypothesis would suggest treatment options quite different from the traditional dopamine-related drugs used for the disease, such as L-dopa.

Thus, Max Truex was coming to visit a doctor with a very different mindset from the conservative neurologists who provided his regular care. Furthermore, Iacono was not a neurologist at all, but a neurosurgeon. By that token, he might be expected to think in terms of dramatic one-time solutions, rather than the painstaking manipulation of drug dosages over months or years.

Truex's visit was also different in the way he was treated. Whether because he had been referred by Iacono's father, because both men had been at USC, or because Truex, like Iacono's father, had been an outstanding runner, Iacono treated him much more as a family friend than as a patient. He picked Truex up at the airport, for example, and had him stay at his own home during his time in Tucson.

When Science Goes Wrong

Although Iacono may have been a radical thinker, he said that it was Truex, not himself, who pushed for radical treatment. ‘I said, “You look well-medicated, I don’t know what I can do for you,” but he said, “No, Bob, I need something.”’

Nothing was decided on during that visit, but Truex continued to call Iacono at his home on a more or less weekly basis for about a year. During this period, the Truexes moved to Boston so that Kay could enter graduate school at Brandeis University – she was hoping to restart her academic career and thus bring some more money into the family.

Truex himself seemed to be researching his treatment options during this period, because on one occasion he said to Iacono, ‘What about this adrenal graft?’ This was a procedure popularised by doctors in Mexico, who took fragments from the patient’s adrenal gland and transplanted them into the brain, near the striatum. Adrenal gland cells produce a certain amount of dopamine, as well as other chemicals, so the thought was that they might make up for the lack of dopamine in the striatum of people with Parkinson’s disease. It turned out that the method didn’t work – the transplanted cells may have survived for a while and maybe even provided some benefit during that time, but within a few months they died, and the patients were as bad off, or worse off, than they had been beforehand. Nevertheless, there was a short period of enthusiasm for the procedure right after the Mexicans published their findings in 1987, and Truex heard about it and proposed it to Iacono as a possible remedy for himself.

Iacono knew that the adrenal transplants were not working as well as advertised, so he talked Truex out of that particular option. But Truex still wanted something done. He kept calling and visiting Iacono. After a few months of this pressure, Iacono felt that he had to do something. So he decided that Truex should undergo a procedure that was even more radical than an adrenal transplant – a transplant of cells from the brains of human fetuses.

Foetal tissue transplantation as a possible treatment for Parkinson’s disease had been pioneered by researchers in Sweden, led by Anders Bjorklund. In the late 1970s, the researchers had created an animal model of Parkinson’s disease: they treated rats with drugs that destroyed their dopamine cells, which left the animals with a

movement disorder that was somewhat analogous to Parkinson's disease. Then they took tissue from the *substantia nigra* of foetal rats – tissue that contained immature dopamine cells – and transplanted it right into the striatum of the treated animals. After a few weeks, the animals' ability to move improved greatly; sometimes they seemed close to normal in their behaviour. The transplanted dopamine cells had survived and matured in their new home, and they were supplying at least some of the dopamine that the rats were missing.

In late 1987, the Swedish group performed the same kind of transplants on two human patients with Parkinson's disease. The *substantia nigra* cells that they transplanted came from human foetal tissue obtained during abortions. Because the aborted fetuses were extremely immature – just seven weeks old and an inch or so in length – and because they were broken apart during the abortion procedure, it took a great deal of skill for the researchers to identify and dissect out the *substantia nigra* while leaving other unwanted tissues behind. But they accomplished this task successfully. They then drilled small holes in their patients' skulls, passed long hollow needles down through the cerebral cortex into the underlying striatum, and then pumped the foetal cells through the needles into the striatum. The patients recovered satisfactorily from the surgery, and the researchers observed them over the following weeks and months to see whether the transplants had any effect.

In fact, the patients did seem to improve. Although Bjorklund's group didn't publicise their research immediately, word spread through the neuroscience community. So Iacono heard about the Swedish experiments, and he suggested to Truex that a foetal transplant might benefit him, too.

Truex agreed; in fact, he leapt at the idea. Kay may have been a bit more cautious, but she went along with Max's wishes. 'I was in favour because it was what he wanted,' she said. And, though an observant Catholic, she had no moral qualms about the use of foetal tissue. 'I didn't have a religious problem with it, because I knew that the tissue was going to be thrown away – it wasn't as if people were aborting children for this purpose.'

The next question was where and how Truex was to get the transplant. Iacono first contacted the Swedish group, hoping that

When Science Goes Wrong

they would accept Truex as a patient. They turned him down, however, because they preferred Swedish patients who they could monitor for long periods after the transplant. Then Iacono found out that a group at Yale University was gearing up to perform similar transplants and was looking for volunteers. But, as it turned out, the Yale group also wanted people who lived locally. A group in England also turned Truex down. Iacono was stymied.

Then, in November 1988, the first American foetal transplant was performed by a team led by neuroscientist Curt Freed of the University of Colorado. Freed had researched the technique for years, first in rats (like the Swedes) and then in monkeys. This research was funded by federal grants, but when he began the human work Freed had to turn to private funds because the Reagan administration, concerned about the abortion issue, had banned the use of federal grants to support transplantations involving human foetal tissue.

For the first transplant, Freed selected a volunteer by the name of Don Nelson, a 51-year-old Denver man who had been suffering from Parkinson's disease for 19 years. As with Max Truex, Nelson was deteriorating fast and he was desperate to try some new therapy. Freed obtained foetal tissue from an abortion clinic in the Denver area, dissected out the *substantia nigra* and (with the collaboration of a neurosurgeon) injected the foetal cells into the striatum on one side of Nelson's brain.

If the Swedes were publicity-shy almost to the point of secretiveness, Freed was the very opposite: he held a news conference to announce the transplant just two days after the operation, long before he could know whether Nelson would experience any benefit from the procedure. Part of the reason for his haste may have been that the Yale group was about to do their first transplant – it actually took place just a few weeks later. In the world of medical research, priority is a significant issue.

Iacono did not contact Freed to see if he would accept Truex as a volunteer. Although I don't know the exact reason, the fact is that Freed and Iacono didn't get along. 'I have no respect for Curt Freed,' Iacono told me. 'The results he's got have been so poor that no one should be continuing that work.' And he described some of Freed's more recent experiments, in which he did mock surgery on some patients to establish a placebo control group, as 'asinine and

unethical.' When I talked with Freed in 2000 – we were collaborating on a book about Parkinson's disease – he was equally blunt about Iacono. He described Iacono as 'one of the most, shall we say, provocative neurosurgeons who has not been censured by the academy of neurosurgery but whom everyone has said should be censured.' Of course, this was after he learned about what happened to Max Truex; it's possible that he was better disposed toward Iacono back in 1988.

In any event, Iacono said that he made great efforts to find a place where Truex could get a foetal transplant. 'I tried all my friends all over the world – Sweden, Britain, Japan. I tried and tried. And eventually, after two or three years of following Max, I realised I had to do it myself.'

Do the transplant himself? Iacono was a neurosurgeon, certainly, so he had a general expertise in brain surgery. He also had a particular interest in Parkinson's disease. But the handful of foetal transplants that had been done up to that time were performed by large research teams at major medical centres. The teams included basic neuroscientists, immunologists, and neurologists as well as neurosurgeons, supported by large amounts of money from public or private sources. The researchers had years of practice doing the transplants in laboratory animals before they ventured to touch a human being. They had studied every variable that might affect the success of the procedure, such as the right age of the foetus that would supply the tissue, the proper technology for dissecting, handling, storing, and administering the cells, and the right kind of drugs to give the patients to prevent the transplanted tissue from being rejected. The researchers performed brain scans, using advanced technology, to measure dopamine function in the brains of their volunteers before and after the transplants. And they carried out rigorous neurological testing of their volunteers for months before and after the transplants, so that any benefit or harm of the transplants could be assessed. All of this was overseen by university committees composed of doctors, administrators, and ethicists, whose role was to ensure that the volunteers were not exposed to undue risk, and that they were fully aware of those risks that could not be avoided. How was Iacono to replicate all of this, virtually by himself, and without any funds to support the project?

When Science Goes Wrong

Iacono was based at a major medical centre – the University of Arizona Health Sciences Center in Tucson – but he would not have been allowed to do the transplant there, for two reasons. First, the operation was outside his recognised area of expertise. ('I just don't do stuff like that,' was how he put it.) Second, there was a general ban on medical research using human foetal tissue at the University of Arizona – a state school in a very conservative state.

Iacono thought that the best way to overcome these difficulties was to do the operation overseas. He first thought of Japan, which he visited from time to time. But his Japanese colleagues were reluctant to get involved. Then, while in Japan, he met a doctor who worked in a cancer hospital in Zhengzhou, the capital of Henan province in China. The doctor suggested Iacono perform the transplant there: tissue from aborted foetuses was readily available, he said, and regulatory control was lax. 'It's no muss, no fuss in China,' as Iacono put it.

Travelling halfway around the world for a surgical operation is not unheard of. Plenty of people fly from faraway places to have a procedure that is not available in their home countries. Still, what Iacono was proposing to do was very different: rather than take Truex to an established centre of excellence where the local doctors were experienced in the transplant procedure, he was planning to take him to what, in many people's minds, could be considered the 'back of beyond', and more specifically to a hospital whose staff had absolutely no experience in this kind of surgery. Iacono was going to have to do almost everything himself, so if he was to succeed, he needed to be fully prepared.

Iacono did in fact prepare himself as best he could. 'I was learning about immunosuppression, I studied up on the embryology, I read all the papers, and I developed my own technique – I solved millions of problems,' he said. Still, he did not perform foetal-cell transplantations in animals as the other researchers had done, nor did he go and witness human foetal-cell transplant surgeries at one of the centres that were already doing them.

One problem stood out as the most challenging. The transplantation procedure involved stereotaxic surgery – that is, the use of a calibrated metal frame attached rigidly to the patient's skull. By mounting the injection needle on the frame at a specified

location and angle, it could be driven into the brain a predetermined distance and the surgeon would know that the tip was in the desired target, the striatum. Iacono was familiar with the techniques of stereotaxic surgery, but such surgery couldn't be carried out at the Zhengzhou hospital – they simply didn't have the facilities.

Iacono thought up a fairly devious scheme to get around this difficulty. In April of 1989, he operated on Truex at the Veterans Administration hospital in Tucson. The operation was a 'thalamotomy' – the destruction of part of a brain region called the thalamus. This is a procedure that is sometimes done to alleviate the tremor of Parkinson's disease, and in fact Truex's tremor was lessened, according to Kay. But the thalamotomy wasn't the main reason for taking Truex into the operating room that day. Rather, it was the 'cover' (as Iacono himself put it) for a second procedure that he carried out 'on the QT' immediately after the first.

In the second procedure, Iacono inserted three catheters, or plastic tubes, into Truex's brain, using the stereotaxic equipment that was available at the VA hospital. The tips of two of the tubes were guided into the left and right striatum. Iacono placed the tip of the third catheter in a ventricle – one of the large, fluid-filled cavities inside the brain. It was the left lateral ventricle, which is close to the striatum on that side. This catheter was of a different design than the other two: its back end was connected to a small rubber bladder, or reservoir, that Iacono implanted under Truex's scalp. Then he sewed up the scalp incision with all three catheters still in place. The idea was that later, in China, he would be able to push the foetal tissue down the tubes and he'd know that it would end up in the striatum or in the ventricle, even without stereotaxic control. The catheters would serve as pre-targeted delivery chutes. What is more, Iacono thought that the inevitable tissue damage caused by the presence of the tubes would actually be beneficial to the transplant: some research suggested that damaged brain tissue releases chemicals called growth factors that encourage cell survival.

Truex recovered uneventfully from these procedures, and a couple of weeks later the two men set out for China. They flew first from Tucson to Los Angeles. This was convenient for Kay, because the family had temporarily moved back from Boston to Manhattan Beach, where they were overseeing some work on their old property

When Science Goes Wrong

there which they planned to sell. Thus, Kay and Gene had the opportunity to come up to the airport and visit Max and Bob during their layover. Max didn't look like a typical globe-trotting tourist: besides his obvious Parkinsonian symptoms, his head was swathed in bandages to protect the locations where Iacono had drilled through his skull. 'He was in pretty bad shape,' said Kay.

At the airport, Iacono and Kay had a frank conversation. This is how Iacono recounted it to me: 'I told Kay, "You know, I may not be able to bring him back." And she said, "Bob, you've got to try ..." And I said, "I may not be able to bring him back – even in a box." She said, "Bob, please try!" So this wasn't tiddlywinks. And I'm no Texas chainsaw murderer; I'm a very conservative neurosurgeon, by the way.'

When I asked Kay about this, she at first denied any memory of such a conversation, but later she said, 'I'm beginning to remember this 'box' thing. He probably did say something like that. He is very colourful.'

The journey to Zhengzhou was a nightmare. Starting in Los Angeles, Truex and Iacono first flew to San Francisco, where they took a China Airlines flight bound for Shanghai. But fuel supplies ran low, and the pilot had to make an emergency landing in Japan. After a long delay they finally made it to Shanghai.

From Shanghai, they took a train for Zhengzhou. The 500-mile rail trip took 22 hours, mostly occupied by repeated hold-ups as the steam-powered passenger train was forced to yield the track to higher-priority freight or military trains. And there was no food. Train travel in China was difficult at the best of times, but these times were far from the best: on May 4, about 100,000 students and workers had marched through Beijing to protest at government policies, and this unprecedented event had greatly alarmed the government so the entire country was in a state of tension.

Truex had been in a bad way at the start of the trip, but by the time they arrived at Zhengzhou he was virtually immobile: he could not walk even a few steps. Iacono had to carry him off the train; then he was put on a tricycle and wheeled to a waiting car.

Neither man had ever been to mainland China before, and Iacono was unprepared for the primitive conditions that existed at the Zhengzhou cancer hospital. There was no heat or hot water, for

example, and the equipment was rudimentary. The microscopes, which were crucial for the dissection of the foetal tissue, didn't even have built-in light sources. Like children's microscopes in the West, they simply had little mirrors that you aimed at a window.

Another surprise had to do with money. According to Kay, the doctors, at the Zhengzhou hospital, or the hospital administrators, demanded a substantial fee – she thought it was in the range of \$20,000 to \$25,000 – to let the operation go ahead. Don said that Max told him the fee was close to the annual operating budget for the hospital. 'I think they knew what they had,' Kay commented, meaning that they had Max over a barrel. 'Bob was a little taken aback.'

One expectation was fulfilled, however: according to Iacono, foetal tissue was readily available. 'I'd say, "I need some things to dissect, guys, because I haven't had any practice in my country, bring me some stuff." And it would be, "You need foetal? OK, no problem." And a couple of hours later they'd bring me something, and I'd say, "Where did you find that?" and it was, "Oh, in the dustbin."'

In a medical paper describing the case, Iacono said that the samples used for the actual transplantations were obtained in accordance with US National Institute of Health guidelines, which would include obtaining the mother's consent to the use of the tissue for transplantation. Max told Don that a female gynaecologist rode through nearby villages on a bicycle, telling people what she was looking for. If so, she would presumably have had the opportunity to explain the planned use of the tissue to the women who had the abortions, and to get their agreement.

Some other research groups who were doing foetal-cell transplants, such as Curt Freed's, made an effort to tissue-match the foetal tissue to the recipient, at least at the relatively crude level of the ABO system (the system of antigens commonly known as 'blood groups', but actually present in all tissues). Iacono did not tell me whether he did this, but it is unlikely that the Zhengzhou hospital had either the facilities or the expertise to carry out such an analysis. If they didn't, the compatibility of the foetal tissue with Truex's own tissue would be pretty much a hit-or-miss affair. Iacono simply assumed that the tissue would be a mismatch, and he started Truex on immunosuppressant drugs – specifically, steroids and a drug

When Science Goes Wrong

called cyclosporin. The hope was that these drugs would prevent Truex's body from rejecting the transplanted tissue, and he would need to continue to take them for the rest of his life.

Having taken these preliminary steps, Iacono started the transplant procedure, which consisted of three separate operations. On the first day, he took tissue from a foetus that he judged to be 16 weeks old. It's now known that dopamine cells from foetuses this old survive poorly after transplantation – by this age, they have largely or entirely lost their ability to survive in a new host – but at the time that may not have been so clear. At any rate, having obtained the foetal tissue, Iacono opened Truex's scalp and pushed fragments of the tissue down the implanted catheter that led to the striatum on the right side. Then he removed the catheter and closed the scalp incision. It was a very brief operation.

A day or so later Iacono repeated the procedure, again using tissue from a 16-week-old foetus. This time he implanted the tissue in Truex's left striatum, using a somewhat different technique: he loaded the tissue into a small, spring-shaped metal coil and pushed the entire coil down the catheter into the brain tissue; then he removed the catheter, leaving the tissue and the metal coil in place.

For the final procedure, Iacono used tissue from a much younger foetus – it was 16 millimetres long, which would make it only five or six weeks old. Strictly speaking, it was still an embryo and not yet a foetus. This age was younger than what is now considered the optimal age for transplantation, and the tiny size of the foetal brain at that age made accurate dissection a major challenge. Anyway, Iacono dissected out the tissue he wanted, broke it up into tiny fragments, injected it into the reservoir attached to the third tube, and squeezed the reservoir to force the cells down the tube and into the lateral ventricle. After doing so, he left the third tube and reservoir in place, because he planned to use it to take samples of Truex's cerebrospinal fluid at later dates.

Injecting the cells into the ventricle, rather than into the substance of the brain, was a novel and risky step. Iacono did this with the hope that the cells, once in the ventricle, would secrete chemical 'growth factors' that would in turn promote the survival and growth of the cells he had injected into the striatum. He told me that

there were animal experiments to support this hypothesis. But the ventricles of the brain are linked together to form a single tortuous waterway through which the cerebrospinal fluid circulates. So putting cells in the lateral ventricle was rather like throwing alien water plants into a particular pond in the Everglades: one might expect them to spread widely through the system, with unpredictable and possibly harmful consequences.

Iacono told me something even more remarkable about the transplants he performed on Truex. He didn't take the foetal tissue from the brain region that everyone else was using – the *substantia nigra* – even though that was the location of the dopamine cells. 'That just shows you my contempt for the dopamine hypothesis,' he said. Instead, he took tissue from a strip of the brain near the midline, running from near the front of the brain all the way back to the medulla, where the brain narrows down to join with the spinal cord. This zone contains a diverse assortment of cells that use neurotransmitters other than dopamine. As mentioned earlier, Iacono thought that some of these other cells and chemicals played a more central role in Parkinson's disease than the dopamine system.

Truex came through the three procedures without any problems, and within a few days Iacono decided that it was time to go home. But that was easier said than done. On May 20, the Chinese government, in response to the increasing unrest and continued demonstrations, declared martial law. All regular forms of transportation were halted. 'I had to give up all my cash and my passport for several days,' said Iacono, 'and they finally dragged four people kicking and screaming off a Russian turboprop [to make room for us]. I was at the point of tears by then. The tyres of that plane were worn down to the Dacron. But we finally got home, and three days later I heard that that very same plane had crashed and killed everyone onboard.'

Kay added another detail related to her by Max: on June 4, the two men passed through Beijing's Tiananmen Square in a pedal-powered taxi on their way to the international airport. Just hours later, the massacre began that cost the lives of hundreds or thousands (accounts differ) of students and workers.

Truex finally rejoined his family in Manhattan Beach. He was very tired, but hopeful that the cost and exhaustion of the trip would

When Science Goes Wrong

pay off for him. And, according to Kay, he had good things to say about all the people who cared for him in China. In that connection, Jim Slosson added a fairly implausible detail that he supposedly learned from either Truex or Iacono. During his hospital stay in China, Slosson said, Truex spent his time running up and down the corridors after the Chinese nurses. 'The good-looking ones,' Slosson added, with a wink.

Before long, the family moved back to Boston. According to Iacono, Truex's condition improved greatly over the 18 months that followed the surgery. Already at six weeks his facial expressions were livelier, and soon thereafter his speech and his gait improved. By 15 months, he was able to resume normal daily activities, Iacono told me, and he even began running again in order to coach one of his sons. Iacono described the overall improvement as 'so dramatic.' He did, however, offer one caveat, saying that no one had checked to see if the immunosuppressant drugs that were used to prevent rejection of the grafted cells might themselves have a beneficial effect on the symptoms of Parkinson's disease. When I asked him to expand on this far-from-the-mainstream notion, Iacono clammed up. 'I'm not going to tell you that stuff,' he said. 'I have to write my own book about that.'

Iacono wasn't alone in his belief that Truex did well after the transplant: other people who knew Truex before and after the operation were of the same opinion. 'There was nothing dramatic or immediate,' said Kay. 'I remember, I think it was about a year after surgery, Bob called to see how he was doing, which he did periodically, and I said, "You know what, I think Max is doing very, very well, because it just occurred to me that for about the last three weeks to a month I haven't been doing anything for him, he's been doing everything for himself."'

Don Truex agreed. 'His facial expressions were better, his speech was better,' he said. 'There's no question in my mind that he was substantially improved.' Jim Slosson also said that Max was better after the transplant.

Iacono was impressed enough with the results that he took other patients to China for similar transplants, but he performed the surgery in a more modern hospital in Shanghai rather than in Zhengzhou. He described some of these cases, including Truex's, at several scientific meetings that he attended.

In the second year after the surgery, Truex visited a neurologist by the name of Raymon Durso, who is a specialist in Parkinson's disease at the Veterans Administration hospital in Boston. Durso also has an academic appointment at Boston University Medical School.

'I think I saw him a total of three times,' Durso told me. 'He definitely said he was improved. However, when I went over the history, his doctors had, for example, added Deprenyl, and so I was never willing to attribute his improvement to the surgery.'

The United States' Food and Drug Administration (FDA) approved Deprenyl for the treatment of Parkinson's disease in the same month that Truex received his transplants. In some patients it significantly alleviates the symptoms of the disease, and it can also cause euphoria, so that a person may feel and act more upbeat even if the physical symptoms are unchanged.

The last time Truex visited Durso was in March of 1991, a year and ten months after the trip to China. Durso says that Truex seemed quite well at that time, aside from some swelling of his ankles. Such swelling can be caused by mild kidney failure, and Durso confirmed this diagnosis by means of blood tests. Chronic mild kidney failure is a common finding in people who are treated with immunosuppressant drugs.

Although he seemed reasonably well to Durso, Truex evidently did not seem well to himself, because right around that same time he began telling Kay that he was dying. Kay didn't take him seriously at first, but he was insistent. When she asked him what made him say that, he replied, 'I just know, I just don't feel the same, I just know I'm dying.' Then, over a period of ten days or so, Max began giving Kay specific instructions concerning his death. 'He told me about his life insurance policy,' Kay says. 'He had me go into Boston and sell off some stocks that he didn't want to cause problems afterwards, and he had me write down that he wanted to be cremated, and where he wanted his ashes.' He also gave Kay power of attorney for medical matters, and told her that he did not want to be resuscitated if the question arose. Kay realised that Max was very serious about his belief that his life was ending, even if he couldn't verbalise the reasons.

Two weeks after the visit to Durso, on the morning of Sunday, March 24, Kay woke to find that Max was already out of bed. She got up and went downstairs in her nightgown, and she found Max

When Science Goes Wrong

in the living room. This is her account of what followed. ‘I asked him if he wanted me to fix him some breakfast, but he said, “No I’ve already had something. I’m kind of tired, I think I’m just going to lie down on the couch for a while.” I wasn’t feeling well either, so I lay down on the other couch. The kids weren’t up yet. I was dozing, and then I heard him moving around, and it was like he caught himself on the arm of the couch, so I got up and I said, “Do you need help, are you OK?” He said the strangest thing – it was like something changed, something was going on in his head – and he said out of the clear blue, “I think I can still pee in a can.” And then he just kind of slumped. I looked up, and my son John had come down the stairs and was right there. By then we were in the doorway between our living room and our kitchen, and I said to John, “Grab a chair quick, Dad’s going down.” So he came over and we got Max into a chair, and he kind of slumped over and it was like he was snoring: a puff and a puff and a puff and then a rush of air out of his lungs. And I said, “John, stay with Dad, I’m going to get dressed, I’m going to take him to the emergency room, I don’t know what’s happening.” And I came back down as soon as I could and said, “How is he?” John said, “Fine, Mom, he’s sleeping.” But he wasn’t sleeping.’

Kay called an ambulance, but it took 20 minutes or so to arrive. Kay knew that Max was dead. Gene and Mindy came downstairs, and the four of them talked about what had happened. When the paramedics finally arrived and began to insert a tracheal airway, Kay remembered what Max had told her just a few days previously, and said, ‘He doesn’t want this.’ The paramedic said, ‘Do you have something legal?’ and Kay explained about her power of attorney.

Then the paramedic took out the tracheal tube and said, ‘He’s been gone for some time, it would have been much too late anyway. I was doing it mainly for the children’ – presumably to assure them that everything possible had been done to save their father. The ambulance crew left, after telling Kay to call a funeral home and have them collect the body.

Even though she and the three children were in a state of extraordinary shock and grief, Kay remembered something else that Max had told her during his final days, which was that, when he died, she should contact Iacono because he would want Max’s brain

saved for scientific study. And when Kay Truex called Iacono later that Sunday to let him know that Max had died, he was indeed very eager to have Truex's brain examined. He knew that it might be possible to detect the presence of the transplanted cells. To show that these cells had survived for nearly two years after the transplant surgery would be an important scientific finding, and it would provide a partial validation for the foetal tissue treatment. There was no reason to suspect, at that point, that the transplants had anything to do with Truex's death – he might easily have died from some other unrelated condition such as a heart attack. So, after some calls between Iacono and Dr Durso, Kay was asked to have Max's body taken to the New England Medical Center.

She did arrange for the funeral home to take him there, and Kay and the children followed the hearse in their own car. When they got to the hospital, the staff, who had been alerted to the situation, had Max's body taken to the morgue, and Kay returned home. In the face of her own and her children's grief, she had to alert other members of the family. She called Don, leaving it to him to break the news to his and Max's mother – a widow of 10 years and now the mother of two sons who had died suddenly and unexpectedly.

I asked Kay whether Max's last words, 'I think I can still pee in a can', meant anything to her. She said that it seemed to be just a random fragment recalled from his childhood. 'I know that his mother had told me that she potty trained the boys by having them pee in a can,' she said. 'They liked the noise.'

In the regular way, brain autopsies are leisurely affairs. Within a day or two of the person's death, the brain is removed and placed in a bucket of formaldehyde, where it sits for several days or weeks until it has hardened sufficiently that it can be easily sliced and studied.

But this was not to be the regular way. Iacono wanted to use very sensitive chemical procedures to detect the presence of the transplanted cells. These methods identified certain enzymes present in those cells – enzymes that were responsible for synthesising the particular neurotransmitters that those cells produced. For these procedures to work, the brain tissue had to be as fresh as possible.

When Science Goes Wrong

Iacono said that he asked Durso to arrange for the brain to be removed that same day. Durso began making phone calls to locate someone who would be able to do the procedure. He tried several neuropathologists who he knew at the Veterans Administration hospital, but because it was a Sunday, and already late in the day, he wasn't able to track anyone down. Then he tried to page other neuropathologists around town, and finally, during the evening, he reached Rebecca Folkerth.

Folkerth was on the staff at the New England Medical Center, but she wasn't on duty at the hospital that day, or even on call. 'But I was one of the crazy foolish people who leave their beeper on all the time,' she told me. 'I answered my page on the Sunday night and I said, "OK, I'll come and do this autopsy." It sounded like Durso was having trouble getting anyone to help him.'

Folkerth reached the hospital around 9pm. 'Once I got there, I got a call from Dr. Iacono,' she says. 'He told me the whole history and said, "Can I ask you to take some of the tissue fresh and freeze it?" I said, "OK, fine." It's not the usual thing – we usually put it in formalin and let it harden for a couple of weeks.'

So Folkerth donned scrubs and a face shield, identified Truex's body, wheeled it out of the cooler, and began the procedure. First, she placed a block under Truex's head, raising it a few inches to make it more accessible. Then she took a scalpel and made a long, curving incision in his scalp, starting behind one ear, passing over the top of the head, and ending behind the other ear. This separated the scalp into front and back halves. She took hold of the front half and pulled it down over Truex's face, and then she pulled the back half backward and down over his neck, leaving most of his skull exposed. Then she took a power saw and began to cut off the entire top of Truex's skull. Even with the power saw it was hard physical work, and it took about 30 minutes. In usual circumstances, the job is often left to the *diener*, the technician who runs the morgue.

Having removed the skullcap, Folkerth cut the cranial nerves and the blood vessels that supply the brain, and then sliced across the top of the spinal cord so that Truex's brain was now entirely separated from the rest of his body. Being in its natural, unhardened state the brain was jelly-like and difficult to handle, but Folkerth placed it in a dish, took a long, broad-bladed knife,

and sliced the brain as best she could into a series of slabs, each about a half-inch thick.

Up to now, Folkerth hadn't noticed anything unusual about Truex's brain. 'But as I was cutting it,' she told me, 'I made this observation, "Gee, look at this strange stuff in the ventricles, in the third and fourth ventricles, and in the lateral ventricles also." I thought, "Isn't that odd?" and I took a bunch of pictures. And I thought, "That looks like cartilage; isn't that weird!" Even to the naked eye it looked like cartilage, and there were hairs – you could see them, just eyeballing it – the gross pictures are extremely dramatic.' By 'gross' pictures, she meant the pictures she took with a regular camera, as opposed to pictures taken through a microscope. She didn't mean that they *looked* gross, though in fact they did.

Brains don't usually contain cartilage or hair, of course. Nor bone or skin, which she later discovered were also present. 'You could see the hair shafts,' she went on. 'So I knew there was something very strange about this right away. Oh, this was the most strange thing I'd ever seen, and at this point it was the middle of the night. I was the only one there, looking at this case and thinking, "What the hell is this?" It was creepy. So here I am taking these pictures and thinking this is some mistake; this is a tumour – a teratoma.'

A teratoma is a tumour derived from embryonic stem cells that retain the capacity to form many or all of the body's various tissues. Most commonly, teratomas form in the ovary, but they can be found in other places and in either sex. Teratomas contain a chaotic mixture of tissues, which can include cartilage, skin, hair, bone, gut, retina, brain, glands, even teeth. It's as if the tumour is trying to form a foetus, but without any conception of how the various tissues are supposed to be arranged.

It looked like something similar had been happening inside Truex's head. Lumps of glistening cartilage lined the floor of one of the ventricles. Part of one of the lateral ventricles was completely filled with a waxy, skin-like tissue. The fourth ventricle, which is located in the brainstem near nerve centres concerned with breathing and other vital functions, was packed full of hair and other tissues, so much so that some of the surrounding brain structures were compressed and discoloured.

When Science Goes Wrong

A teratoma? Folkerth knew that that was exceedingly unlikely. Teratomas can on rare occasions occur in the brain, but if so it would usually be in the brain of a newborn infant or young child. A brain teratoma in a 53-year-old man would be a diagnosis of desperation. Then Folkerth remembered the case history that Iacono had recounted to her – the Parkinson's disease and the transplants. And as she examined the brain slices further, she began to figure things out. In the left striatum, she found the metal coil that Iacono had used to convey the second transplant into Truex's brain. And she saw the catheter that Iacono left in place after the third transplant. The tip of the catheter was still located in the left lateral ventricle. 'I thought, "It can't be a tumour; it's the tissue they infused in there." There was no other explanation.'

Folkerth froze some specimens of tissue for later microscopic examination, as Iacono had requested. She put other parts of the brain in formalin. Then she reassembled Truex's head as best she could: She replaced the skull cap, pushed the scalp back over it, and sewed the incision roughly together. Having returned his body to a more-or-less lifelike appearance, she wheeled it back into the cooler. The next day it was collected by the funeral home, and later it was cremated in accordance with Truex's wishes.

This whole experience left a big impression on Folkerth, and so over the next few months she devoted a lot of her free time to analysing the tissue samples from Truex's brain. In the left and right striatum, where Iacono had deposited the tissue from the two 16-week-old foetuses, she found no surviving cells from the transplant, only scar tissue. This was consistent with findings from other research groups, who have reported that tissue from foetuses this old has a very low chance of surviving the transplantation procedure. Folkerth concluded that the reported improvement that Truex had experienced was not due to the presence of any transplanted nerve cells in his brain. Either just the damage caused by the injections had a beneficial effect, which didn't seem terribly likely, or some other factor, such as the new drug that Truex received, was the reason.

What about all the weird tissues in the ventricles? These presumably arose from the tissue that Iacono had dissected from the very young, five- to six-week-old foetus and had injected into the left lateral ventricle. Folkerth believes that Iacono mistakenly included

some tissue that was not from the embryo's brain at all – tissue from just outside the brain that normally would have developed into the overlying bone, cartilage, skin, and hair. Those cells could have drifted through Truex's ventricular system, found some attachment point, multiplied, and followed their own normal developmental pathway, unaware that they were now in a highly inappropriate location.

I asked Folkerth whether she thought that the blockage of the ventricular system was the cause of Truex's death. 'In my heart of hearts, yes,' she said. 'I think that was the cause, but it wasn't a complete autopsy so I can't rule out a heart attack, pulmonary embolus, or something like that. The story that his wife told me made it sound like he had respiratory failure. I think he had gradual changes in the brainstem [where breathing is controlled] that couldn't be compensated for any longer, because we saw a lot of chronic changes, microscopically.'

Iacono had been the initial driving force behind the autopsy, and it would have been natural for him to participate in publishing the findings that emerged from it. In fact, at a scientific meeting three months after Truex's death, he announced that the results of the autopsy were 'pending'. But later, Iacono seemed to lose interest in having the results published. And that wasn't too surprising, perhaps, because the findings suggested not only that two of the transplants had failed to survive, but also that the third had survived only too well, and had quite likely caused Truex's death.

Still, Raymon Durso and Rebecca Folkerth felt that the findings should be published, because at that time there were only one or two autopsy studies of foetal transplant recipients, and the results in Truex's case seemed to offer an important warning to researchers in the field. So, after some delay, Folkerth and Durso decided to write the paper on their own without Iacono. For the clinical details of the case they would rely on what he had told them and what he had reported at that scientific meeting.

After more than a year's delay, they sent their manuscript to the *New England Journal of Medicine*, because that journal had already published several articles about foetal-cell transplantation for Parkinson's disease. But the manuscript was rejected. 'That was

funny,' says Folkerth. 'I thought this was something that was definitely worthy of being in that particular journal. There seemed to be kind of a pro-transplant point of view in the other articles they had published.'

What Folkerth didn't know was that her manuscript was reviewed by Curt Freed, a major enthusiast for foetal-cell transplantation and an author of one of those 'pro-transplant' articles in the *NEJM*. As he later told me, Freed recommended that the manuscript be rejected. The reason was a concern that, even though it only described what he considered a 'therapeutic misadventure', it could bring the entire procedure into disrepute. (Nevertheless, Freed has had his own setbacks with the procedure. Three years after Truex's death, one of Freed's patients suffered a brain haemorrhage during the transplant operation; he died a few weeks later.)

The rejection of the manuscript caused another delay, but in 1995 Folkerth and Durso sent the manuscript to another, less prestigious journal, *Neurology*. It was accepted, and it appeared in 1996, five years after the autopsy it described. Folkerth and Durso didn't name Iacono in the body of their article. 'I didn't want to indict the guy, I didn't want to be too accusatory,' Folkerth says. Still, they did thank both Iacono and Kay Truex in a footnote, so anyone in the field would have realised which case they were talking about.

Iacono didn't respond to the *Neurology* article, or if he did his response didn't get published. But the journal did publish a response from a research team that had begun to do foetal-cell transplants at the University of South Florida in 1993. Evidently, this team, like Curt Freed, was worried that Folkerth's article would throw the field of foetal-cell transplantation into disrepute, and they expressed their feelings about what Iacono had done in unusually strong language. 'This is a case of extremely poor tissue dissection,' they wrote. 'One wonders why this transplant was performed in China,' they added, 'outside of State and Federal regulations, Institutional Review Board oversight, and peer review scrutiny.' 'We should not be surprised,' they concluded, 'that poor science leads to poor outcomes.'

Iacono never abandoned his conviction that Truex was greatly helped by his transplants, and he rejected the idea that the tissue in his ventricular system caused his death. 'There weren't any signs of increased intracerebral pressure,' he told me. 'He wasn't having

urinary incontinence, he wasn't showing signs of dementia, he wasn't complaining of headaches. He was acting normally, and his wife said he came in and sat down and died. That just doesn't sound like [ventricular blockage]. His death was officially signed out as a heart attack.' (Kay says that Max's death certificate lists only 'Parkinson's disease' and does not mention any immediate cause for his death.)

A few months after Truex's death, a memorial service for him was held at USC; it was attended not only by family members but also by many of Truex's old team-mates from his college and Air Force days. Jim Slosson was there too. As a more lasting memorial, his family and friends endowed a college scholarship for athletes from Warsaw High School. There is also a Max Truex Memorial interscholastic track meet that is held in Indiana every May.

Max's mother, Lucile, died exactly nine months after Max, on Christmas Eve of 1991. She had been in frail health, but the shock of her son's death accelerated her own, Kay believes. Kay stayed on in Boston for a year so that Gene could graduate from high school, and then she and the younger children moved back to Fresno, the city of her birth. In 1993 she attended her 30th high school reunion, and there she ran into Michael De Justo, a classmate she had been out of touch with for decades. Within a few months they married.

During all the years since Truex's death, neither Kay nor anyone else in the family learned what Rebecca Folkerth found in his brain – not even after her findings were published. Kay tells me that she did have a phone conversation with Folkerth some time after her husband's death, but all she learned from that was that he had not suffered a stroke. As to whatever else Folkerth said during the conversation, Kay said, 'I could not for the life of me understand what she was saying to me.' Thus it is possible that Folkerth did describe what she found, but did so in technical language that failed to communicate much to a layperson like Kay.

It wasn't until the summer of 2005, when I met Kay in Fresno, that she learned about what had happened and saw Folkerth and Durso's published report. She was of course surprised to learn that none of the foetal brain cells had survived, and shocked to see the photographs of the nodules, hair, and other foetal tissues that were growing in the ventricular system of Truex's brain.

When Science Goes Wrong

Kay did take issue with one thing in the report. Folkerth and Durso, citing Kay as their source, had written in the summary of their report that Max had died after a 'several-hours interval of progressive lethargy and breathing difficulties' – a description that would be very compatible with an impairment of brainstem function. 'That is completely incorrect,' said Kay. She reiterated that Max had not complained of tiredness until a few minutes before his death, and had not shown any breathing difficulties until the very last moments of his life. 'I think they went back after the fact,' she said, meaning that Folkerth and Durso misremembered what Kay had told them in a manner that fit in better with their pathological findings. To be fair to Folkerth and Durso, the main text of the report does not state that Truex had breathing difficulties for hours prior to his death, but only tiredness.

I had thought that Kay might react to what she learned with considerable hostility toward Iacono, but she didn't – not in the couple of hours I was with her, at least. On the contrary, she re-emphasised her belief that Iacono had acted out of good intentions and that Max himself had urged Iacono to go ahead with the procedure. 'If this [report] is true, it's very sad in a way,' she commented, 'because it means that what Max set out to do to help himself may have actually gone completely the other direction.'

Iacono stopped doing foetal transplants in 1989, after he had operated on a total of 25 to 30 patients, all of them in China. 'When you start adding up the negative aspects of foetal grafts,' he told me, 'including the risks of immunosuppression as well as infection from the foetus and contamination from these other things, the risks of foetal grafts are pretty high.' In a paper published in 1994, Iacono argued that foetal transplantation was a less successful treatment for Parkinson's disease than another neurosurgical procedure called pallidotomy, which involves destruction of part of a brain region called the pallidum. At the time I visited Iacono he was specialising in pallidotomy operations: he did them, as he put it, in 'industrial numbers'.

Some other centres, such as Curt Freed's, continue to perform the transplants, with mixed results: about one-third of the patients have been greatly helped, some have seen little change in their condition, and a few have developed disabling side-effects of the procedure,

such as involuntary flailing movements. In Freed's hands, the transplanted cells do survive, and no patients have been afflicted by the teratoma-like growths that Max Truex experienced.

In the waiting room of Iacono's Redlands office, I noticed a life-size portrait of a surgeon operating, with a man standing next to him guiding his scalpel. Oddly, that man was wearing neither gown nor mask nor gloves. It took me a moment to figure out the reason: that man was Jesus. Iacono had become quite religious since the Truex days, and he no longer approved of abortion or of using aborted foetal tissue for science. 'I went from "I don't care what I'm doing here with a foetal graft" to becoming a right-to-lifer,' he said. 'I'd see these little guys, and after a while you realise you can tell how they're going to grow up and what their personality's going to be like; you can almost name them.'

After my meeting with him in 2000, things did not go well for Iacono. In October 2001, California's Loma Linda University Medical Center, where Iacono was doing his surgery, revoked his privileges, meaning that he could no longer operate there. According to the California Medical Board and newspaper accounts, the hospital's action was provoked by a laundry list of misbehaviours, starting in 1992 with an episode of 'inappropriate language and inappropriate touching'. In 1994, Iacono allegedly used some drugs that were not approved by the FDA. This was followed in 1998 by 'yelling and abusive behaviour toward staff', which earned him an official reprimand and six months of anger-management therapy. In May 1999, Iacono was said to have become angry with a scrub technician in the operating room, and to have grabbed her hand, causing an injury. In the spring of 2000, according to the allegations, he told a nurse, within earshot of a deceased patient's family, that she had 'killed' the patient. And at some unspecified time, Iacono was accused of having allowed a medically unqualified nurse practitioner to drill holes through patients' skulls.

Following the loss of his surgical privileges at Loma Linda, Iacono applied for privileges at another hospital, Desert Regional Medical Center in Palm Springs. But, according to the California Medical Board, Iacono falsely answered 'no' to a question about whether he had ever had his surgical privileges suspended or revoked. Because of this and the other alleged actions by Iacono, the

When Science Goes Wrong

Medical Board brought a formal accusation against him in 2004, and in September 2005 Iacono was ordered to surrender his medical licence, meaning that his medical career in California was over. Two years later, while flying alone from Los Angeles to Mississippi, he crashed into a mountainside in New Mexico and was killed. He was 55 years old.

Why did Truex agree to participate in a project that he must have realised was hazardous in the extreme, and which quite likely killed him? Why did he agree to be operated on by someone who had absolutely no previous experience in this kind of work, in an absurdly remote location, and without any kind of regulatory control? In part, of course, it was simply his desperate desire for relief from his incurable and progressive illness. But also, he placed a great deal of trust in Iacono. He was a family friend, after all. And Iacono, whatever failings he may have had, was an extraordinarily vivid and persuasive talker. At our meeting in 2000, after lecturing me for several hours Iacono left the room and a medical student who had been sitting in on our meeting turned to me and said, 'You haven't seen him at his finest. He gets very dynamic – a very charismatic fellow!'

Then Iacono popped back in and said to me, hopefully in jest, 'My Mafia friends can track you down and cut your tongue out if this doesn't work out for us.'