

# ROOM TO BREED

**Nearly 100,000 embryos are frozen in Britain every year. With couples reluctant to destroy potential babies, fertility clinics face a pressing problem: where to store them all**

REPORT BY ROSIE TAYLOR

PHOTOGRAPHS BY DAVID VINTNER

At the private Bridge Clinic in London a cane loaded with plastic straws containing human embryos is lowered into a tank of liquid nitrogen at a temperature of minus 196C for storage





Jodie Nicholson's daughter, Nel, now three, was conceived with IVF. It costs £540 a year to store the remaining four embryos

**M**arta Jansa Perez lifts a blue plastic lid off the metal tank and a cloud of nitrogen vapour billows upwards. "We have space in here for the next few years, but demand is ramping up," she says. "We might run out of room sooner or later." Perez, 56, is director of embryology at Bridge Clinic, a private fertility clinic tucked away behind a newsagent's near the British Library in London. Just as the library has had to build vast underground vaults — and a giant repository in Yorkshire — to store its rapidly expanding collection of books, fertility clinics such as Perez's are having to find their own ingenious solutions to a uniquely 21st-century storage problem.

Just a few decades ago "test tube babies" were novel. Now one in 34 babies born in the UK is conceived in a laboratory. But the boom in assisted reproduction has created a side-effect: a growing stockpile of leftover embryos. In 1991, when the UK fertility regulator the Human Fertilisation and Embryology Authority (HFEA) began its records, 4,938 embryos created in the UK were put into cryo storage — frozen, at no small cost, in liquid nitrogen at minus 196C. By the mid-2000s about 50,000 embryos were being frozen every year. In 2021 a record high of almost 100,000 embryos were stored. Today an average of 267 newly created embryos are being frozen every day.

The question of what we should do with hundreds of thousands of potential

human lives in the freezer is a thorny one. Fertility clinics' energy-hungry cryo-storage facilities are already struggling to keep up with demand. And that demand is predicted to grow exponentially in the coming decades thanks to a significant change to the law.

In July last year the time limit for storing embryos, eggs and sperm was increased from 10 to 55 years. The increase was hailed as a progressive step, giving people more flexibility about when to have children, as it enables children diagnosed with cancer to freeze eggs or sperm for use in adulthood — or even for donations between generations, such as if a mother wants to store her eggs

**"IT MAKES NO FINANCIAL SENSE TO KEEP PAYING TO STORE MY EMBRYOS, BUT I FEEL GUILTY THAT THEY MIGHT BE DISCARDED"**

for her infertile daughter to use in the future. But while, previously, every year a proportion of embryos in storage would reach the ten-year time limit and be destroyed, now they can be kept for decades, leaving families with a decision to make.

It is not just the 55-year rule that has increased the numbers of embryos in Britain. Fertility treatment is becoming more accessible. Although research shows NHS funding for in vitro fertilisation (IVF) is becoming increasingly restricted, the women's health minister Maria Caulfield indicated in May that she expected to see an end this year to rules requiring same-sex female couples to pay for up to 12 cycles of artificial insemination treatment before accessing IVF on the NHS.

And last month the social media influencers Megan and Whitney Bacon-Evans ended a legal challenge to the "discriminatory" policy after their local health authority, NHS Frimley Integrated Care Board, agreed to address the issue.

Scientific advances over the past two decades also mean more viable embryos are now typically produced in each IVF cycle. Over the same period, survival rates of frozen embryos have more than doubled thanks to scientists transitioning from "slow freezing" to vitrification. Through this method of plunging embryos into liquid nitrogen they instantly transform into a glass-like state, free of ice crystals that can damage their structure. The developments mean that, overall, the average live birth rate from a frozen embryo transfer is now 27 per cent, similar to "fresh" transfers (although success rates decline with the age of the potential mother).

A record 291,241 embryos were created in UK fertility clinics in 2021, up 64 per cent on 2001. But whereas 20 years ago about one in four were frozen, now the rate is higher than one in three. Since late 2007 the HFEA has asked clinics to transfer just one embryo at a time and freeze the rest. In the 2000s transferring two or three embryos at once was common practice and, as a result, about one in four IVF pregnancies resulted in twins or triplets, a rate 20 times higher than in natural conception. This put the mothers' and babies' health at risk. The rate has dropped to just 5 per cent, but the regulator now faces a new ethical conundrum: the number of embryos being frozen annually has doubled since it started the campaign.

#### A little life

Jodie and Steve Nicholson, from Sheffield, spent six years trying to conceive before discovering that problems with Jodie's fallopian tubes and ovaries meant natural conception was impossible. They then spent £10,000 on an IVF cycle that created six viable embryos. The first transferred successfully and resulted in the birth of their daughter, Nel, now three. A second transfer ended in miscarriage earlier this

year, leaving four embryos. They pay £45 a month (£540 a year) to store them.

"I worked so hard to get them and the embryos are so precious to me — they are my babies — but there's no way on earth that I can have five children," says Jodie, 33, a school administrator who has written a book, *I(V)F Only!*, about her experiences. She hopes a second or third attempt to transfer the remaining embryos is successful, but it will mean the couple still have some left. "It makes no financial sense for us to keep paying to store them," she says, "but I feel so guilty even thinking about the fact they might be discarded, it's awful." They plan to continue to pay to store them for the foreseeable future.

For patients, these tiny bundles of cells are laden with emotion and meaning. IVF parents often see them as siblings to a living child, says Helen Watt, an expert in bioethics at the Bios Centre research institute in London. "Some are also struck by the fact that an embryo in storage might easily have been the one selected for birth, in which case it would be their current child who remained in storage," she adds.

Under the new 55-year time limit patients must renew their consent every ten years but, if they choose not to continue, they must sign paperwork agreeing their embryos can be destroyed. Before the time limit was extended, many simply waited until the ten years were up, says Eleanor Wharf, a clinical embryologist at Guy's and St Thomas' NHS Foundation Trust. "Now patients have to choose... it can be extremely difficult, given all the emotional and physical effort needed to create them."

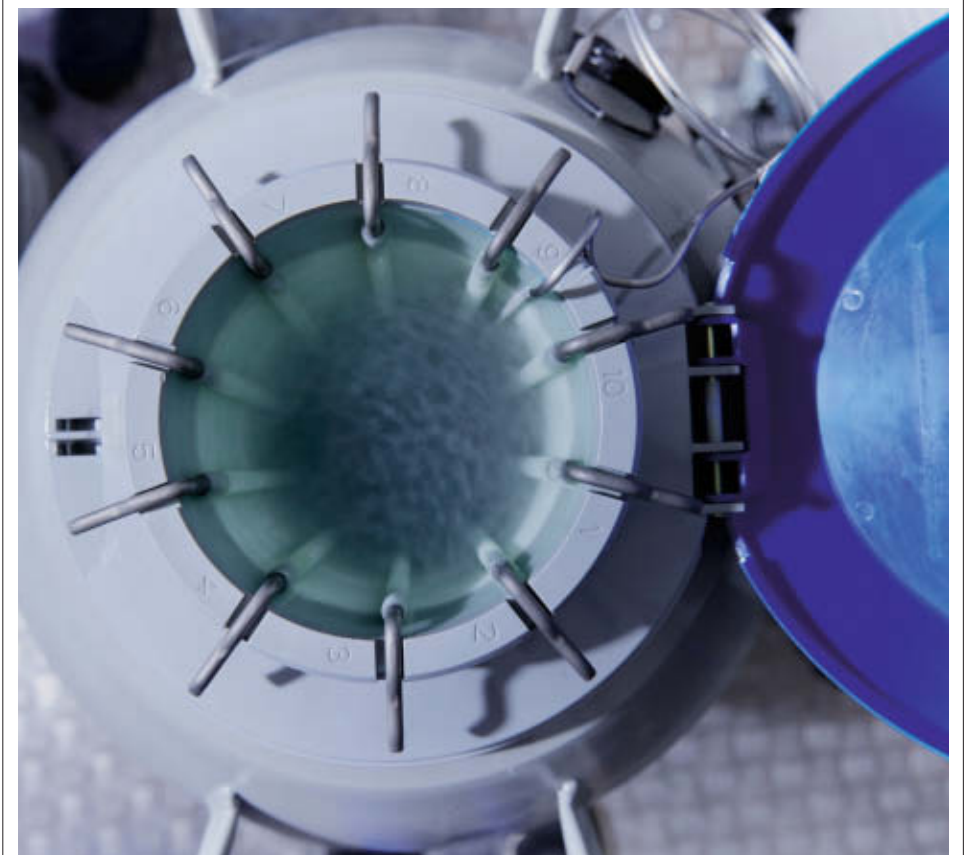
An embryo is human life at its earliest stages of development, from conception until eight weeks later, when it becomes a foetus. During fertility treatment, embryos are created in a laboratory when eggs are fertilised in a petri dish (in IVF) or through injection of a sperm cell into the egg (intracytoplasmic sperm injection or ICSI).

A fertilised egg is nurtured in the lab for five or six days until it develops into a blastocyst: a rapidly dividing ball of cells, about the size of a fine grain of sand, ready to be transferred into a woman's womb. About one in three embryos transferred will go on to implant successfully, leading to pregnancy. At the blastocyst stage in natural conception, a woman would be considered three weeks pregnant. So it's understandable that many prospective parents view their five-day-old embryos as their babies — and find the idea of allowing them to be destroyed as distressing as a miscarriage. "For patients, it is a life or death decision. And what bigger decision could you be asked to make?" says Dr Catherine Hill, interim chief executive of the charity Fertility Network.

Patients who are unable to use their embryos can ask for them to be taken out of storage and destroyed at any time. ►

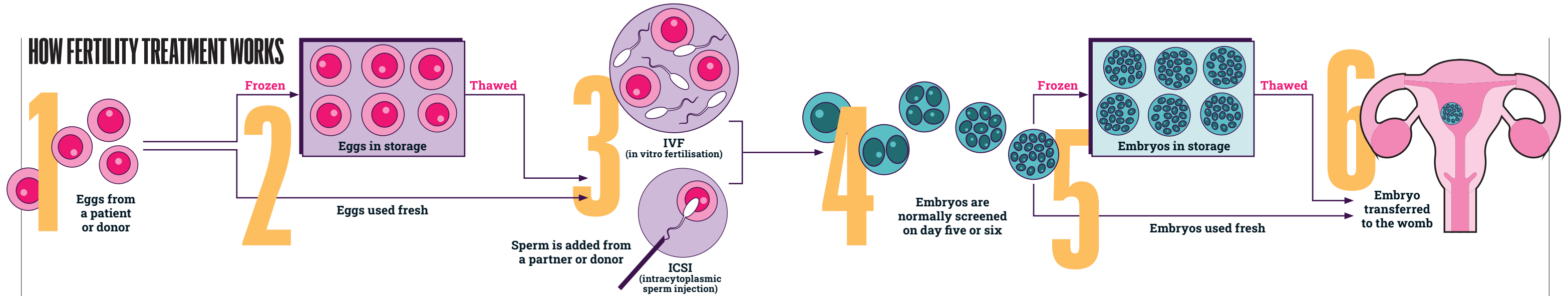


Liquid nitrogen passes through a piping system, top left, before being used to fill storage tanks for the embryos, above left and below, as well as the "baths" in which they are frozen, above right





## HOW FERTILITY TREATMENT WORKS



But, more often than not, they don't, instead paying the annual storage costs of £300-£550.

"I don't know how I would ever be able to say, 'Please destroy the embryo,'" says Laura Upson, 34, a police officer from Hadleigh, Essex. She went through a single cycle of IVF, which created four embryos. The first attempt to transfer two failed, but she is now pregnant after a successful transfer of a third, which had been frozen. A fourth embryo remains in storage. "If we don't go on to use the last one, I can guarantee I will be paying each year for the rest of my life to keep it there," she says.

Couples — and, increasingly, single women — go through physically and emotionally gruelling, and often expensive fertility treatment to create their embryos. Fertility clinics aim to create as many viable embryos as possible in a cycle of treatment. The highest-quality one will be transferred, while any remaining embryos are stored. They can then be used if the initial "fresh" embryo fails to lead to pregnancy or if the parent wants to have another child later.

Frequently, parents do not use leftover embryos. Some may have had all the children they want, while others may be unable to afford to have another child — or to pay up to £5,000 for an embryo transfer. NHS funding is available to help a couple conceive only if neither individual has had a child before. Others still may want more children but cannot because of health problems or concerns about their age. (IVF parents are older on average when they first have children, often having tried to conceive naturally for years before starting treatment.) But even when they know they will never use their embryos, many patients would rather pay what will now be decades of storage fees than let them go. Which leaves clinics with a space problem.

### Space invaders

At Bridge Clinic, Perez wears an oxygen-level monitor as she uses a gloved hand and an arm-length metal pole to lift a cup-shaped



**Louise Brown, 45, above, was the world's first "test tube baby", born in Oldham on July 25, 1978**

cannister out of the freezing liquid in the tank. The metal cannister contains 22 triangular plastic compartments in different colours. Each is allocated to an individual patient or couple. Inside each is room for up to ten sealed plastic straws containing a single embryo, egg or sperm sample.

Similar in appearance to large milk churns, the aluminium storage vessels are by far the most common storage method used in the UK. Unfortunately, they don't use space efficiently, says Ian Blackham, business development executive at the cryo-storage equipment supplier Biopharma Group. "Liquid-storage vessels are not much more than buckets of liquid nitrogen," he says. "They're sophisticated, insulated buckets but, in essence, that's what they are." And they are filling up and multiplying.

Offices at Wharf's NHS clinic are being converted into additional storage space — but there are only so many rooms that can be commandeered. While embryos might be microscopic, the equipment required to freeze them is both bulky and dangerous, requiring dedicated rooms complete with ventilation systems and oxygen detectors. Liquid nitrogen burns skin but it is most dangerous when it evaporates, as it expands to 700 times its

volume. The colourless and odourless gas knocks oxygen out of the air and can silently suffocate those exposed to it.

The UK's biggest private fertility provider, Care Fertility, has also had to requisition offices and store rooms at some of its 14 laboratories to create additional space for the 63,000 embryos in its care.

In general the system is far from efficient. Because only one compartment of the "buckets" can be used per patient to avoid mix-ups, and many patients freeze just one or two embryos, as little as a tenth of the space inside a vessel is used at any one time.

An alternative, Blackham explains, is nitrogen vapour tanks. Unlike liquid nitrogen, the freezing vapour fills the space, meaning more of it can be used. Although the tanks are bulkier, he tells me, they can store about 10,000 embryos, compared with a maximum of about 1,200 in a liquid vessel. But Blackham estimates they are used by just 5 per cent of clinics because they have significant risks. At minus 190C, nitrogen vapour is six degrees warmer than liquid and the temperature can rise quickly as vapour escapes whenever the door is opened. Frozen embryos will survive only if kept well below minus 130C. As a result, clinics keep storage tanks below minus 150C

at all times. Machines using vapour have to be rigged with complex temperature monitoring and alarm systems, all at extra cost to clinics and, ultimately, their patients.

### AI to the rescue

Blackham believes the answer to the UK's embryo storage space problem lies instead in using artificial intelligence to maximise efficient use of space. In the past few years there has been a global boom in technology that uses AI to track and monitor patients' samples. Some new tanks can robotically retrieve samples when needed, a bit like a vending machine, bypassing the need to open a door and risk vapour escaping. And when the system knows exactly where each sample is, they can be stacked up in all available space, eliminating the need for individual patient compartments. It is a similar concept to the robot-assisted storage the British Library has been building at its campus in Yorkshire. "It is the future," Blackham says.

Care Fertility's chief scientific officer, Professor Alison Campbell, is less convinced. "The robotic systems are



**Purpose-built out of town cryo-storage centres, such as this one in Connecticut, are popular in the US and are a potential solution**

amazing technology, but I'm holding back. I want some long-term safety data. And I don't like the fact they might be difficult to override." Instead, the group is in the process of replacing its traditional storage vessels with bigger, modern tanks with multiple storage layers and five times the capacity — but only double the footprint.

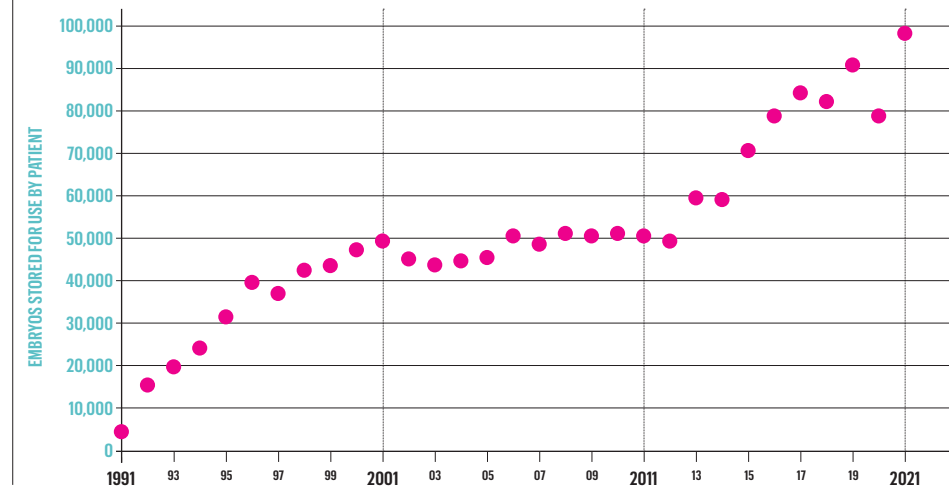
For now many British clinics like Campbell's are opting for semi-automated systems, where computers monitor the location of embryos, but humans oversee all movement in and out of storage.

Care does use some AI-driven technology, including thermal-imaging cameras to pick up subtle changes in external temperature and scales that detect tiny weight fluctuations in the vessels, indicating vapour has escaped. However, this is a safety measure and won't help cram more into existing space — or meet growing demand.

### The big shed solution

The only real answer to that, Campbell believes, is off-site storage. Shipping embryos to huge out-of-town independent cryo-storage centres is a popular practice in the US, but in the UK strict regulation means traditionally only fertility clinics have held licences to store them. The only third-party centre licensed for storage in the UK — Future Health Biobank in Nottingham — has been empty of embryos since it received its licence in 2016. There is resistance to the concept, Campbell says. "We've got such rigorous and robust systems right under our noses. It takes a lot of trust to move our samples off site." ▶

## NUMBER OF EMBRYOS STORED IN THE UK EACH YEAR SINCE RECORDS BEGAN





### Who pays?

How much fertility clinics charge is a prickly issue. The regulator has already criticised them for flogging unproven “add on” treatments, such as assisted hatching (where a tiny hole is made in the layer of proteins around a fertilised egg) and endometrial receptivity array (where a biopsy is taken from the womb lining to predict the best time for transfer). Hiking storage prices would risk angering those who feel they are being strong-armed into paying to save their embryos. Sarah Norcross, director of the fertility research charity Progress Educational Trust, says embryo storage should never be “unaffordable”. But she believes slightly higher fees could be “a useful prompt” to help encourage parents to make the decision to stop storage once their families are complete.

But Fertility Network’s Hill believes making patients pay extra is unfair since many decide to store embryos only because of rationing of NHS funding. Official NHS guidance says a treatment cycle should include the transfer of all created embryos, usually one by one, until pregnancy is achieved. But the charity has found that, in at least one in ten areas, the NHS pays for only one “fresh” transfer — leaving patients with no choice but to pay to store any other embryos unless they can afford for each additional transfer to be made privately.

“If embryos are created within the NHS, they should be used within the NHS,” Hill says. “To not do so is unethical and will be contributing to increasing numbers of embryos in storage.”

### A new way of thinking

Could the answer to the storage crisis lie in making fewer embryos in the first place? At the recent annual meeting of the European



**A straw is loaded with an embryo before it is plunged into a liquid nitrogen bath to freeze it rapidly, a process known as vitrification**

**“ASKING PARENTS TO GIVE CONSENT TO UNSPECIFIED RESEARCH ON THEIR EMBRYOS IS LIKE ASKING THEM TO SIGN A BLANK CHEQUE”**

Society of Human Reproduction and Embryology, delegates heard how some Spanish IVF clinics are experimenting with fertilising fewer eggs during an IVF cycle and freezing the remaining eggs and sperm separately instead. The theory is that scientific advances mean conception with thawed sperm and eggs is now more reliable, but should parents not be willing or able to have another child, it is psychologically easier for them to let go of these cells.

In the UK, though, clinics are still creating as many embryos as possible — often more than patients are likely to need. Other than using, destroying or storing them, patients’ only other options are to donate them to other families or to research. But in the UK only 185 were donated to others in 2021.

Parents can struggle with the concept of donating their child’s full sibling to other families, says Rachel Cutting, director of compliance and information at the HFEA. And donating to science obliges patients to link up with a specific research project working with their clinic. In 2019 only 675 embryos were donated for research.

Norcross adds: “Present arrangements are so cumbersome that clinics are perversely disincentivised from enabling such donations... These embryos are a precious resource for scientific research.” The study of embryos helps us understand how early life develops, the function of stem cells and genetic diseases. It could also help scientists find causes for unexplained infertility or recurrent miscarriage.

Some experts and charities are calling for a national storage bank for the nation’s spare embryos, where they can be used by researchers for any project. In a step towards this, the HFEA consulted earlier this year on plans to allow patients to donate embryos “to research” generally, instead of a specific project. It is expected to report back this autumn.

Cutting, a former embryologist, says donating to research is often “a very positive thing” for patients, many of whom view it as akin to donating a loved one’s organs. There is no doubt making it easier will also help reduce pressure on storage space. But Ilaria Bertini, of Bios Centre, disagrees. “Asking parents to give consent to research of some unspecified kind on their embryos is asking them effectively to sign a blank cheque,” she says. “It is impossible for them to give full informed consent in the absence of any information on how their embryo will be used.”

Others view the idea of a central embryo bank as having more space-age uses for protecting the future of humankind or — just like the British Library — as a record of life today for future generations. “We have seed banks for plants, why don’t we have a national embryo donation bank?” Hill says. “We need to be forward thinking about this because, if not, we’re squandering our most precious resource.” ■