HOW THE CASE AGAINST THE MMR VACCINE WAS FIXED

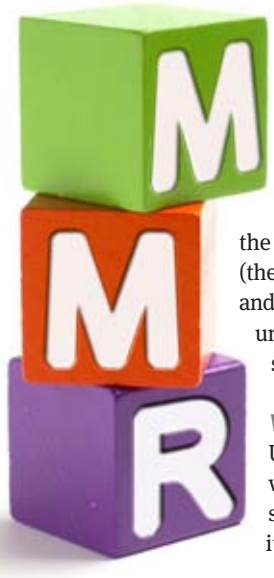
In the first part of a special *BMJ* series, **Brian Deer** exposes the bogus data behind claims that launched a worldwide scare over the measles, mumps, and rubella vaccine, and reveals how the appearance of a link with autism was manufactured at a London medical school

When I broke the news to the father of child 11, at first he did not believe me. "Wakefield told us my son was the 13th child they saw," he said, gazing for the first time at the now infamous research paper which linked a purported new syndrome with the measles, mumps, and rubella (MMR) vaccine.[1] "There's only 12 in this."

That paper was published in the *Lancet* on 28 February 1998. It was retracted on 2 February 2010.[2] Authored by Andrew Wakefield, John Walker-Smith and 11 others from the Royal Free Hospital and School of Medicine, London, it reported on 12 developmentally challenged children, and triggered a decade long public health scare.

"Onset of behavioural symptoms was associated by the parents with measles, mumps, and rubella vaccination in eight of the 12 children," began the paper's "findings." Adopting these claims as fact, its results section added: "In these eight children the average interval from exposure to first behavioural symptoms was 6.3 days (range 1-14)."

Mr 11, an American engineer, looked again at the paper: a five page case series of 11 boys and one girl, aged between 3 and 9 years. Nine children, it said, had diagnoses of "regressive" autism, while all but one were reported with "non-specific colitis." The "new syndrome" brought these together, linking brain and bowel diseases. Child 11 was the penultimate case.



Running his finger across the paper's tables, over coffee in London, Mr 11 seemed reassured by his anonymised son's age and other details. But then he pointed at table 2—headed "neuropsychiatric diagnosis"—and for a second time objected.

"That's not true."

Child 11 was among the eight whose parents apparently blamed MMR. The interval between his vaccination and the first "behavioural symptom" was reported as 1 week. This symptom was said to have appeared at age 15 months. But his father, whom I had tracked down, said this was wrong.

"From the information you provided me on our son, who I was shocked to hear had been included in their published study," he wrote to me, after we met again in California, "the data clearly appeared to be distorted."

He backed his concerns with medical records, including a Royal Free discharge summary. Although the family lived 5000 miles from the hospital, in February 1997 the boy (then aged 5) had been flown to London and admitted for Wakefield's project, the undisclosed goal of which was to help sue the vaccine's manufacturers.

"The regulator's main focus was whether the research was ethical. Mine was whether it was true"

Wakefield's "syndrome"

Unknown to Mr 11, Wakefield was working on a lawsuit,[3] for which he sought a bowel-brain "syndrome" as its centrepiece. Claiming an undisclosed £150 (€180; $230) an hour through a Norfolk solicitor named Richard Barr, he had been confidentially put on the payroll for two years before the paper was published, eventually grossing him £435 643, plus expenses.[4]

Curiously, however, Wakefield had already identified such a syndrome before the project that would reputedly discover it. "Children with enteritis/disintegrative disorder [an expression he used for bowel inflammation and regressive autism[5] form part of a new syndrome," he and Barr explained in a confidential grant application to the UK government's Legal Aid Board,[6] before any of the children were investigated. "Nonetheless the evidence is undeniably in favour of a specific vaccine induced pathology."

The two men also aimed to show a sudden onset "temporal association"—strong evidence in product liability. "Dr Wakefield feels that if we can show a clear time link between the vaccination and onset of symptoms," Barr told the legal board, "we should be able to dispose of the suggestion that it's simply a chance encounter."[7]

But child 11's case must have proved a disappointment. Records show his behavioural symptoms started *too soon*. "His developmental milestones were normal until 13 months of age," notes the discharge summary. "In the period 13-18 months he developed slow speech patterns and repetitive hand movements. Over this period his parents remarked on his slow gradual deterioration."

That put the first symptom two months earlier than reported in the *Lancet*, and a

month before the boy had MMR. And this was not the only anomaly to catch the father's eye. What the paper reported as a "behavioural symptom" was noted in records as a chest infection.

"Please let me know if Andrew W has his doctor's license revoked," wrote Mr 11, who is convinced that many vaccines and environmental pollutants may be responsible for childhood brain disorders. "His misrepresentation of my son in his research paper is inexcusable. His motives for this I may never know."

The father need not have worried. My investigation of the MMR issue exposed the frauds behind Wakefield's research. Triggering the longest ever UK General Medical Council fitness to practise hearing, and forcing the *Lancet* to retract the paper, last May it led to Wakefield and Walker-Smith being struck off the medical register.[8-10]

Wakefield, now 54, who called no witnesses, was branded "dishonest," "unethical," and "callous."[8-10] Walker-Smith, now 74, the senior clinician in the project, was found to have presided over "high risk" [11] research without clinical indication or ethical approval. The developmentally challenged children of often vulnerable parents were discovered to have been treated like the doctors' guinea pigs.[10]

Lawsuit test case

But Mr 11 was not the first parent with a child in the study whom I interviewed during my investigation. That was Mrs 2: the first of the parents to approach Wakefield. She was sent to him by an anti-vaccine campaign called JABS. Her son had regressive autism,[12] longstanding problems with diarrhoea,[13] and was the prime example of the purported bowel and brain syndrome—still unsubstantiated 14 years later.[14] This boy would appear in countless media reports, and was one of the four "best" cases in Barr's lawsuit.

I travelled to the family home, 80 miles northeast of London, to hear about child 2 from his mother. That was in September 2003, when the lawsuit fell apart after counsel representing 1500 families said that, on the evidence, Barr's autism claims would fail.[15] By that time, Mrs 2 had seen her son's medical records and expert reports, written for her case at trial.

Her concerns about MMR had been noted by her general practitioner when her son was 6 years old. But she told me the boy's troubles began after his vaccination, which he received at 15 months. "He'd scream all night, and he started head banging, which he'd never done before," she explained.

"When did that begin, do you think?" I asked.

"That began after a couple of months, a few months afterward, but it was still, it was concerning me enough, I remember going back."

"Sorry. I don't want to be, like, massively pernickety, but was it a few months, or a couple of months?"

"It was more like a few months because he'd had this, kind of, you know, slide down. He wasn't right. He wasn't right. Before he started."

"Not quicker than two months, but not longer than how many months? What are we talking about here?"

"From memory, about six months, I think."

The next day, she complained to my editors. She said my methods "seemed more akin to the gutter press." But I was perplexed by her story, since there was no case in the *Lancet* that matched her careful account.

According to the paper, child 2 had his "first behavioural symptom" two weeks, not six months, after MMR. This was derived from a Royal Free medical history (citing "head banging" and "screaming" as the start) taken by Mark Berelowitz, a child psychiatrist and a coauthor of the paper. He saw Mrs 2 during the boy's admission, at age 8, after she had discussed her son's story with Wakefield.[10]

As I later discovered, each family in the project was involved in such discussions before they saw the hospital's clinicians. Wakefield phoned them at home, and must have at least suggestively questioned them, potentially impacting on later history taking. But I knew little of such things then, and shared my confusion with Walker-Smith, who I met shortly after Mrs 2.

"There is no case in the paper that is consistent with the case history [Mrs 2] has given me," I told him. "There just isn't one."

"Well that could be true," the former professor of paediatric gastroenterology replied, disarmingly. He knew the case well, having admitted the boy for the project and written reports for Barr, who paid him £23 000.[16]

"Well, so either what she is telling me is not accurate, or the paper's not accurate."

"Well I can't really comment," he said. "You really touch on an area which I don't think should be debated like this. And I think these parents are wrong to discuss such details, where you could be put in a position of having a lot of medical details and then try to match it with this, because it is a confidential matter."

It was not merely medically confidential, it was also legally protected: a double screen against public scrutiny. But responding to my first MMR reports in the *Sunday Times*, in February 2004,[17] the GMC decided to investigate the cases and requisitioned the children's records.

The regulator's main focus was whether the research was ethical. Mine was whether it was true. So as a five member disciplinary panel trawled through the records, with five Queen's counsel and three defendant doctors, I compared them with what was published in the journal.[18]

Multiple discrepancies

The paper gave the impression that the authors had been scrupulous in documenting the patients' cases. "Children underwent gastroenterological, neurological, and developmental assessment and review of developmental records," it explained, specifying that *Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV)* criteria were used for neuropsychiatric diagnoses. "Developmental histories included a review of prospective developmental records from parents, health visitors, and general practitioners."

HOW THE LINK WAS FIXED

The *Lancet* paper was a case series of 12 child patients; it reported a proposed "new syndrome" of enterocolitis and regressive autism and associated this with MMR as an "apparent precipitating event." But in fact:

- Three of nine children reported with regressive autism did not have autism diagnoses at all. Only one child clearly had regressive autism
- Despite the paper claiming that all 12 children were "previously normal," five had documented pre-existing developmental concerns
- Some children were reported to have experienced first behavioural symptoms within days of MMR, but the records documented these as starting some months after vaccination
- In nine cases, unremarkable colonic histopathology results—noting no or minimal fluctuations in inflammatory cell populations—were changed after a medical school "research review" to "non-specific colitis"
- The parents of eight children were reported as blaming MMR, but 11 families made this allegation at the hospital. The exclusion of three allegations—all giving times to onset of problems in months—helped to create the appearance of a 14 day temporal link
- Patients were recruited through anti-MMR campaigners, and the study was commissioned and funded for planned litigation

MMR vaccine

Journalist Brian Deer

Andrew Wakefield

Coauthor John Walker-Smith

STEVE PARSONS/PA ARCHIVE/PA

When the details were dissected before the panel, however, multiple discrepancies emerged. A syndrome necessarily requires at least some consistency, but, as the records were laid out, Wakefield's crumbled.

First to crack was "regressive autism," the bedrock of his allegations.[3] "Bear in mind that we are dealing with regressive autism in these children, not of classical autism where the child is not right from the beginning," he later explained, for example, to a United States congressional committee.[19]

But only one—child 2—clearly had regressive autism.[20] Three of nine so described clearly did not. None of these three even had autism diagnoses, either at admission or on discharge from the Royal Free.

The paper did not reveal that two of this trio were brothers, living 60 miles south of the hospital. Both had histories of fits and bowel problems recorded before they received MMR. The elder, child 6, aged 4 years at admission, had Asperger's syndrome,[21] which is distinct from autism under DSM-IV, is not regressive,[22] and was confirmed on discharge.[10] His brother, child 7, was admitted at nearly 3 years of age without a diagnosis,[10] and a post-discharge letter from senior paediatric registrar and *Lancet* coauthor David Casson summarised: "He is not thought to have features of autism."

The third of this trio, child 12, was enrolled on the advice of the brothers' mother—reported in media as a JABS activist, who had herself "only relatively recently" blamed the vaccine. Child 12 was aged 6 at admission and had previously been assessed for possible Asperger's syndrome at Guy's Hospital, London, by a renowned developmental paediatrician. She diagnosed "an impairment in respect of language"—an opinion left undisturbed by Berelowitz.[10]

Mrs 12 was a GMC witness at its mammoth hearing, which between July 2007 and May 2010 ran for 217 days. She explained that the brothers' mother had made her suspicious of MMR and gave her Barr's and Wakefield's names. Mrs 12 approached them and filed a statement for legal aid before her son was referred.

"It was like a jigsaw puzzle—it suddenly seemed to fit into place," she told the panel, describing how she concluded, four years after the boy was vaccinated, that MMR was to blame for his problems. "I had this perfectly normal child who, as I could see, for no apparent reason started to not be normal."

The 12 children were admitted between July 1996 and February 1997, and others had connections not revealed in the paper, almost as striking as the trio's. The parents of child 9 and child 10 were contacts of Mrs 2, who ran a group that campaigned against MMR. And child 4 and child 8 were admitted—without outpatient appointments[10]—for ileocolonoscopy and other invasive procedures, from one Tyneside general practice, 280 miles from the Royal Free, after advice from anti-MMR campaigners.

Pre-existing problems

Both child 4 and child 8 were among the eight whose parents were reported to have blamed the vaccine. But although the paper specified that all 12 children were "previously normal," both had developmental delays, and also facial dysmorphisms, noted before MMR vaccination.

In the case of child 4, who received the vaccine at 4 years, Wakefield played down problems, suggesting that early issues had resolved. "Child four was kept under review for the first year of life because of wide bridging of the nose," he reported in the paper. "He was discharged from follow-up as developmentally normal at age 1 year."

But medical records, presented by the GMC, give a different picture for this child. Reports from his pre-MMR years were peppered with "concerns over his head and appearance," "recurrent" diarrhoea, "developmental delay," "general delay," and restricted vocabulary. And although before his referral to Wakefield his mother had inquired about vaccine damage compensation, his files include a report of a "very small deletion within the fragile X gene," and a note of the mother's view that her concerns about his development began when he was 18 months old.

"In general, his mother thinks he developed normally initially and subsequently his problems worsened, and he lost some of his milestones, but he subsequently improved on a restrictive exclusion diet," wrote his general practitioner, William Tapsfield, referring the boy, then aged 9, after a phone conversation with Wakefield. "The professionals who have known [child 4] since birth don't entirely agree with this, however, and there is a suggestion that some of his problems may have started before vaccination."

Similarly with child 8, who was also described in the *Lancet*

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- Feature: Wakefield's "autistic enterocolitis" under the microscope (*BMJ* 2010;340:c1127)
- News: Wakefield is struck off for the "serious and wide-ranging findings against him" (*BMJ* 2010;340:c2803)
- News: Lancet retracts Wakefield's MMR paper (*BMJ* 2010;340:c696)

as having overcome problems recorded before MMR. "The only girl . . . was noted to be a slow developer compared with her older sister," the paper said. "She was subsequently found to have coarctation of the aorta. After surgical repair of the aorta at the age of 14 months, she progressed rapidly, and learnt to talk. Speech was lost later."

But Wakefield was not a paediatrician. He was a former trainee gastrointestinal surgeon with a non-clinical medical school contract.[10] And his interpretation differed from that of local consultants (including a developmental paediatrician and a geneticist) who had actually looked after the girl. Her doctors put the coarctation side by side with the developmental delay and dysmorphism, and noted of her vocabulary that, before MMR at 18 months, she "vocalised" only "two or three words."

"[Child 8's] mother has been to see me and said you need a referral letter from me in order to accept [child 8] into your investigation programme," the general practitioner, Diana Jelley, wrote to Wakefield at referral, when the girl was aged 3 and a half years. "I would simply re-iterate . . . that both the hospital and members of the primary care team involved with [child 8] had significant concerns about her development some months before she had her MMR."

The girl's general practice notes also provide insight into the background to the 12 children's referrals. After person(s) unknown told Mrs 8 that her daughter may have inflammatory bowel disease, Jelley wrote: "Mum taking her to Dr Wakefield, Royal Free hospital for CT scans/gut biopsies ?Crohn's—will need ref letter—Dr Wakefield to phone me. Funded through legal aid."

The child was "pale"

The remaining five children served Wakefield's claims no better. There was still no convincing MMR syndrome.

Child 1, aged 3 years when he was referred to London, lived 100 miles from the Royal Free and had an older brother who was diagnosed as autistic. Child 1's recorded story began when he was aged 9 months, with a "new patient" note by general practitioner Andrea Barrow. One of the mother's concerns was that her son could not hear properly—which might sound like a hallmark presentation of classical autism, the emergence of which is often insidious. Indeed, a Royal Free history, by neurologist and coauthor Peter Harvey, noted "normal milestones" until "18 months or so."

This boy was vaccinated at 12 months of age, however. Thus neither 9 nor 18 months helped Wakefield's case. But in the *Lancet*, the "first behavioural symptom" was reported to have occurred "1 week" after the injection, holding the evidence for the lawsuit on track.

Step 1 to achieve this: two and a half years after the child was vaccinated, Walker-Smith took an outpatient history. Although the mother apparently had no worries following her son's vaccination, the professor elicited that the boy was "pale" 7-10 days after the shot. He also elicited that the child "possibly" had a fever, and "may" have been delirious, as well as pale.

"It's difficult to associate a clear historical link with the MMR and the answer to autism," Walker-Smith wrote to the general practitioner, with a similar letter to Wakefield, "although [Mrs 1] does believe that [child 1] had an illness 7-10 days after MMR when he was pale, ?fever, ?delirious, but wasn't actually seen by a doctor."

Step 2: for the *Lancet* Wakefield dropped the question marks, turning Walker-Smith's queries into assertions. And, although Royal Free admission and discharge records refer to "classical" autism, step 3, the former surgeon reported "delirium" as the first "behavioural symptom" of *regressive* autism, with, step 4, a "time to onset" of 7 days.

So here—behind the paper—is how Wakefield evidenced his "syndrome" for the lawsuit, and built his platform to launch the scare.

"It is significant that this syndrome only appeared with the introduction of the polyvalent MMR vaccine in 1988 rather than with the monovalent measles vaccine introduced in 1968," he claimed in one of a string of patents he filed for businesses to be spun from the research.[23] "This indicates that MMR is responsible for this condition rather than just the measles virus."

Three of the four remaining children were seen in outpatients on the same day—in November 1996. None of their families were reported in the paper as blaming the vaccine. Child 5, from Berkshire, aged 7 at admission, had received MMR at 16 months. The paper reported concerns at 18 months, but the medical records noted fits and parental worries at 11 months. Child 9, aged 6, from Jersey, also had MMR at 16 months. His mother dated problems from 18-20 months. Child 10, aged 4, from south Wales, contracted a viral infection, which was suspected by parents and doctors to have caused his disorder, four months after his vaccination.

"Behavioural changes included repetitive behaviour, disinterest in play or head banging," said a question and answer statement issued by the medical school, concerning the *Lancet* 12, on the day of the paper's publication.

Another discrepancy to emerge during the GMC hearing concerned the number of families who blamed MMR. The paper said that eight families (1, 2, 3, 4, 6, 7, 8, and 11) linked developmental issues with the vaccine. But the total in the records was actually 11. The parents of child 5, 9, and 12 were also noted at the

Comparison of three features of the 12 children in the *Lancet* paper with features apparent in the NHS records, including those from the Royal Free hospital

	Regressive autism		Non-specific colitis		First symptoms days after MMR		All three features	
Child No	Lancet	Records*	Lancet	Records†	Lancet	Records‡	Lancet	Records
1	Yes	?	Yes	Yes	Yes	No	Yes	No
2	Yes	Yes	Yes	Yes	Yes	No	Yes	No
3	Yes	?	Yes	No	Yes	?	Yes	No
4	Yes	?	Yes	No	Yes	No	Yes	No
5	Yes	?	Yes	No	No	No	No	No
6	Yes	No	Yes	Yes	Yes	?	Yes	No
7	Yes	No	No	No	Yes	No	No	No
8	No	No	Yes	No	Yes	No	No	No
9	No	No	Yes	No	No	No	No	No
10	No	No	Yes	No	No	No	No	No
11	Yes	?	Yes	No	Yes	No	Yes	No
12	Yes	No	Yes	No	No	No	No	No
Total	9/12	?6/12	11/12	3/12	8/12	?2/12	6/12	0/12

See supplementary data on bmj.com for a version of this table with detailed footnotes.
*Regressive developmental disorder—autism.
†Royal Free hospital pathology service.
‡First behavioural symptoms ≤14 days after MMR.

hospital as blaming the vaccine, but their stated beliefs were omitted from the journal.

Case selection

The frequency of these beliefs should not have surprised Wakefield, retained as he was to support a lawsuit. In the month that Barr engaged him—two years before the paper was published—the lawyer touted the doctor in a confidential newsletter to his MMR clients and contacts. "He has deeply depressing views about the effect of vaccines on the nation's children," Barr said.[24] "He is also anxious to arrange for tests to be carried out on any children . . . who are showing symptoms of possible Crohn's disease. The following are signs to look for. If your child has suffered from all or any of these symptoms could you please contact us, and it may be appropriate to put you in touch with Dr Wakefield."

The listed symptoms included pain, weight loss, fever, and mouth ulcers. Clients and contacts were quickly referred. Thus, an association between autism, digestive issues, and worries about MMR—the evidence that launched the vaccine scare—was bound to be found by the Royal Free's clinicians because this was how the children were selected.

Moreover, through the omission from the paper of some parents' beliefs that the vaccine was to blame, the time link for the lawsuit sharpened. With concerns logged from 11 of 12 families, the maximum time given to the onset of alleged symptoms was a (forensically unhelpful) four months. But in a version of the paper circulated at the Royal Free six months before publication, reported concerns fell to nine of 12 families but with a still unhelpful maximum of 56 days.[25] Finally, Wakefield settled on 8 of 12 families, with a maximum interval to alleged symptoms of 14 days.

Between the latter two versions, revisions also slashed the mean time to alleged symptoms—from 14 to 6.3 days. "In these children the mean interval from exposure to the MMR vaccine to the development of the first behavioural symptom was six days, indicating a strong temporal association," he emphasised, in a patent for, among other things, his own measles vaccine,[26] eight months before the *Lancet* paper.

This leaves child 3. He was 6½ and lived on Merseyside: 200 miles from the hospital. He received MMR at 14 months, with the first concerns recorded in his GP notes 15 months after that. His mother— who 4 years later contacted Wakefield on the advice of JABS[27]—told me that her son had become aggressive towards a brother, and records say that his vocabulary had not developed.

"We both felt that the MMR needle had made [child 3] go the way he is today," the parents wrote to a local paediatric neurologist, Lewis Rosenbloom, 18 months before their son's referral to London. They told him they wanted "justice" from the vaccine's manufacturer and that they had been turned down for legal aid. "Although it is said that the MMR has never been proven to make children to be autistic, we believe that the injection has made [child 3] to be mentally delayed, which in turn may have triggered off the autism."

I visited this family twice. Their affected son was now a teenager and a challenge both to himself and to others. His mother said his diagnosis was originally "severe learning difficulties with autistic tendencies," but that she had fought to get it changed to autism.

As for a connection with MMR, there was only suspicion. I don't think his family was sure, one way or the other. When I asked why they took him to the Royal Free, his father replied: "We were just vulnerable, we were looking for answers."

What was unquestionably true was that child 3 had serious bowel trouble: intractable, lifelong, constipation. This was the most consistent feature among the 12 children's symptoms and signs[28] but, being the opposite of an expected finding in inflammatory bowel disease,[29] was nowhere mentioned in the paper. This young man's symptoms were so severe that he was dosed at his special school, his mother said, with up to five packets of laxative a day.

"You always knew when his stomach was hard," she told me, in terms echoed over the years by many parents involved with Wakefield.


Early report

Ileal-lymphoid-nodular hyperplasia, non-specific colitis, and pervasive developmental disorder in children

No case was free of misreporting or alteration. Taken together, the NHS records cannot be reconciled with what was published, to such devastating effect

"He would start head-butting, kicking, breaking anything in the house. Then he would go to the toilet and release it."

For the Royal Free team, however, when reporting on these patients, such motility symptoms[30] were sidelined in the hunt for Wakefield's syndrome. In almost all the children, they noted commonly swollen glands in the terminal ileum, and what was reported as "non-specific colitis."[31 32] In fact, as I revealed in the *BMJ* last April,[33] the hospital's pathology service found the children's colons to be largely normal, but a medical school "review" changed the results.

In this evolution of the gut pathology to what was published in the *Lancet*, child 3's case was a prime example. After ileocolonoscopy (which GMC prosecution and defence experts agreed was not clinically indicated), the hospital's pathologists found all colonic samples to be "within normal histological limits." But three months after the boy was discharged, Walker-Smith recalled the records and changed the diagnosis to "indeterminate ileocolitis."[34]

"I think, sadly, this was the first child who was referred, and the long-term help we were able to give in terms of dealing with constipation was not there," he told the GMC panel. "However, we had excluded Crohn's disease and we had done our best to try and help this child, but in the end we did not."

So that is the *Lancet* 12: the foundation of the vaccine scare. No case was free of misreporting or alteration. Taken together, the NHS records cannot be reconciled with what was published, to such devastating effect, in the journal (table).

Wakefield, however, denies wrongdoing, in any respect whatsoever.[35] He says he never claimed the children had regressive autism, nor that he said they were previously normal. He never misreported or changed any findings

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- Observations: After Wakefield—the real questions that need addressing (*BMJ* 2010;340:c2829)
- Observations: Reflections on investigating Wakefield (*BMJ* 2010;340:c672)

in the study, and never patented a vaccine for measles. None of the children were Barr's clients before referral to the hospital, and he never received huge payments from the lawyer. There were no conflicts of interest. He is the victim of a conspiracy.[36 37] He never linked autism with MMR.

"Mr Deer's implications of fraud against me are claims that a trained physician and researcher of good standing had suddenly decided he was going to fake data for his own enrichment," he said in a now abandoned complaint against me to the UK Press Complaints Commission. "The other authors generated and 'prepared' all the data that was reported in the *Lancet*. I merely put their completed data in tables and narrative form for the purpose of submission for publication."

But, despite signing up to claim credit for a paper in the *Lancet*, his co-authors Walker-Smith and Murch did not even know which case was which. Walker-Smith said he had "trusted" Wakefield. "When I signed that paper, I signed with good intent," he told the GMC panel. Denying any wrongdoing, he argued that the published report was not even about MMR, but merely described a new "clinico-pathological entity". He said that the admissions to the Royal Free were "entirely related to gastroenterological illness" and how the children were sourced was "irrelevant" and "immaterial." His lawyers said that he was appealing against the panel's decision and on these grounds they had advised him not to respond to my questions.

The journal, meanwhile, took 12 years to retract the paper, by which time its mischief had been exported. As parents' confidence slowly returned in Britain, the scare took off around the world, unleashing fear, guilt, and infectious diseases—and fuelling suspicion of vaccines in general. In addition to measles outbreaks, other infections are resurgent, with Mr 11's home state of California last summer seeing 10 babies dead from whooping cough, in the worst outbreak since 1958.[38] Wakefield, nevertheless, now apparently self employed and professionally ruined, remains championed by a sad rump of disciples. "Dr Wakefield is a hero," is how one mother caught their mood in a recent *Dateline NBC* television investigation, featuring the story of the doctor and me. "I don't know where we would be without him."[39]

Brian Deer journalist, London, UK

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Learning without patients

How far can medical simulation replace clinical experience? **Toby Reynolds** and **Ming-Li Kong** report

LOUIE PSIHOYOS/SCIENCE FACTION/CORBIS

A device that simulates injection of fluid in the spinal cord

Medicine has traditionally approached the problem of the learning curve by supervising trainees' first attempts at new tasks and otherwise relying on them to call for help when they feel overwhelmed. But a growing movement within medical education argues that a better approach is to practise new skills in a realistic simulated environment before they are needed in a critical situation.

"The huge benefit of simulation is that it shifts the steep and dangerous part of the learning curve away from patients," says Ian Curran, consultant anaesthetist and clinical director of the Simulation Technology-enhanced Learning Initiative (STeLI), a workforce development project funded by the UK National Health Service's London Deanery.

"There always has to be a first time with a real patient so we must do all we can to ensure that these early encounters with real patients are as safe as possible."

Simulation ranges from task trainer models that teach a particular skill in isolation to full immersion in a replicated environment with manikins that mimic the physiological responses of real patients and are able to develop, for example, laryngeal oedema, pupillary dilation, or cyanosis.

Use of simulation is growing worldwide. A database maintained by the Bristol Medical Simulation Centre lists more than 1500 dedicated manikin simulation facilities.[1] In Israel, for example, internship doctors are required to attend a five day workshop simulating a variety of challenging scenarios. It has a simulation based exam for anaesthetists, and certification exams for paramedics and all advanced nursing specialties also include simulation. In the United States, anaesthetists who gained board certification after 2000 are now required to do a day of simulation training for recertification. And last year the UK government's chief medical officer recommended that simulation be integrated into British postgraduate training.[2]

Sleepy start

Simulation in medicine has its roots in anaesthesia. The first computer controlled manikin simulator, SimOne, was developed in the 1960s by an anaesthetist and an engineer. They subsequently published a trial showing its effectiveness in teaching anaesthetic trainees.[3]

However, SimOne was expensive and proved to be a little ahead of its time. Only one was built, and activity in the field slowed until the 1980s, when separate groups interested in improving teamwork and preventing anaesthetic errors again took up the idea, recalls Jeffrey Cooper, a biomedical engineer and professor of anaesthesia at Harvard Medical School.

Professor Cooper was involved in awarding funding for some of this early work, which resulted in the parallel development of two computer controlled realistic manikin simulators, both of which formed the basis for commercially produced models. Task trainer simulators are also becoming more sophisticated, with models produced for learning interventional cardiology, endoscopy, and laparoscopic surgery, among others.

Wider environment

Regulatory bodies and healthcare commissioners are starting to agree that using simulation, particularly full immersion techniques, is better for both training and patient safety. A World Health Organization patient safety guide for medical schools also made extensive reference to simulation.[4] Realistic replication of clinical situations not only helps teach technical skills but can also give important insights into how individuals and teams behave and communicate, areas that have been repeatedly identified as common sources of clinical errors.

Simulators are widely used in aviation, and the chief medical officer's report notes how trainee pilots are able to use the technology to recreate difficult situations and how established pilots must also fly regular simulator flights. But one of the key elements in the aviation industry's remarkable reduction in air crashes in the second half of the 20th century was the introduction of mandatory training in teamwork and human behavioural factors.[5]

"Other performance critical industries such as aviation, energy, and the military have made great strides in improving quality and safety by adopting a systems based approach to human factors and crisis management," says Dr Curran. "Healthcare has much to learn from their insights."

Roger Kneebone, reader in surgical education at London's Imperial College, says that there is an important distinction to be drawn between physical simulators and the broader concept of simulation, which tries to create a recognisable clinical environment in which trainees can learn.

"The discourse has been dominated by simulators, by machines, by kit, which has taken away sometimes from the bigger picture," he says.

He notes that simulation has so far mostly evolved for specific job roles, such as surgery or anaesthesia. He believes it needs to balance developing specialty specific skills with teaching different professionals to work better together.

This, Dr Kneebone says, requires a level of realism and sophistication in the environment, not just a manikin. You need to be able to make people feel that they are really doing what is being simulated, he says. "In the surgeon's case that involves having organs and an operation that seem realistic, a situation that doesn't require a superhuman level of suspension of disbelief in order to get into it."

Some simulation centres are complete replicas or real clinical environments. But Dr Kneebone notes that a fully simulated operating theatre may cost up to a million pounds. The high costs limit

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access and make it harder for training to match the realities of clinical work.

Dr Kneebone's work on simulation has included the development of a portable simulated operating theatre[6] that does not try to replicate the real thing but instead includes those elements that trainees need to see, hear, or feel in order to engage with the simulation.

It can be used, for example, to manage a patient from arrival in the emergency department with a traumatic injury to completion of an emergency laparotomy. The surgical models have been made using technology from the film industry to ensure the latex organs are as realistic as possible.

Dr Kneebone hopes projects like the operating theatre, funded by STeLI, will create a middle ground between the use of task trainers to learn isolated skills and the expense of full scale simulation.

"Simulation is a tool for developing better educators, not just for safety, but to educate healthcare providers better and faster . . . and it is clearly doing that"

Efficient training

There is evidence that simulation works. For instance, doctors with simulation training performed better in managing both simulated respiratory arrest[7] and, more importantly, actual cardiac arrest.[8] So now one of the main questions is not whether simulation is a good idea but how to best integrate it into clinical training.

Making training more efficient is a key challenge in the UK, where the European Working Time Directive has cut clinical hours and limited the scope for achieving competence through clinical experience alone.

"The more traditional experiential and perhaps less efficient methods of learning need to be reviewed," says Dr Curran. "It is clear that every training hour needs to pack its educational punch."

Amitai Ziv, founder and director of Israel's MSR simulation centre, has overseen the integration of simulation training into a variety of national courses and exams for many healthcare professions.

Dr Ziv is a former military pilot and was shocked by how aviation training was much more structured and accountable than that in medicine. He sees a wider role for simulation in medicine, such as in selecting candidates for medical training, as already happens in two of Israel's medical schools.

"Our vision was not only to train on simulators but rather to push it to its ultimate application—mandatory courses, screening, licensing, and certification," he says.

"We want to make it part of the routine accountable training of health professionals on the vertical axis, from screening into medical school up to the heads of departments."

He adds that simulation brings a new way to approach training, not just a new technology, with courses concentrating on hands-on application rather than accumulation of knowledge in isolation from the environment in which it will be used.

Professor Cooper also sees simulation techniques changing healthcare education more widely. He thinks that reduced access to clinical learning for nurses and allied health professions such as emergency medical technicians (EMT) will be a powerful driver moving simulation training forward.

"It is harder and harder for an EMT to get practise in an operating room intubating because the risk is greater, there are more and more insurance issues, but the more sophisticated the simulators get, the cheaper and faster it is for him or her to learn everything outside of working on a patient," he says.

"They can get good enough that the first time they do it on a patient they need much less supervised training," he adds.

"I don't think there is any question that all of these forms of simulation will become deeply integrated into the process of training all healthcare practitioners."

Advocates agree that simulation training cannot entirely replace clinical experience.

"I think simulation can only ever be an adjunct to clinical practice," says Dr Kneebone. One area he notes that is difficult to recreate is how people respond when real disasters happen. Another difficulty is the sheer complexity of the human body, particularly for simulating surgery.

"There are clearly limitations that affect the simulation of human beings that you don't get in aircraft cockpits or other more restricted environments where you can control everything," he says. "There is something about the complexity and the contingency of real life clinical practice that defies copying."

"We do need to look critically and conceptually at what simulation can do and can't do," he adds.

"As clinicians and educators we need to decide what it is that is most important for people to learn and use simulation to construct environments that allow people to learn those things."

Nonetheless, it looks as if simulation can reduce the amount of time needed to be spent under supervision and is set to play an important part in healthcare education in the future, Professor Cooper says.

"In the medical education world it is starting to be felt that simulation is a tool for developing better educators, not just for safety, but to educate healthcare providers better and faster . . . and it is clearly doing that," he says.

"You talk to an anaesthesia resident and ask them if they would take care of a patient without a pulse oximeter. That is the way we will think about simulation in the not too distant future," he adds.

Toby Reynolds FY2 doctor, Royal London Hospital, London, UK toby.reynolds@gmail.com
Ming-Li Kong specialist registrar in anaesthesia and intensive care medicine, Royal London Hospital, London, UK

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Watch a video that follows trainee surgeon Sofie Leisby as she learns about laparoscopic surgery, from practising in virtual reality to a real life procedure, at bmj.com/video