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Pennsylvania biomedical engineer is world's expert on medical accidents

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As the surgical team began delicate heart surgery on a premature, two-pound infant, the unthinkable happened. The baby boy suddenly became engulfed in flames.

Doctors and nurses immediately doused the fire and tried to revive the baby at Cedars-Sinai Medical Center in Los Angeles, but it was too late. He died soon after.

"We really aren't sure what happened," a hospital official said at a news conference.

Mark Bruley, summoned to the scene from his lab across the country in Pennsylvania, had an answer in five minutes.

That case, more than two decades ago, was still fairly early in the career of Bruley, a biomedical engineer at the nonprofit ECRI Institute in Plymouth Meeting. Thousands of cases later, he has solidified his reputation as a premier investigator of medical accidents the world over—with a particular expertise in the rare, but horrific, problem of surgical fires.

"He is the world's expert on that problem," said Jeffrey Feldman, division chief in general anesthesia at Children's Hospital of Philadelphia. "There may be a couple of other people that have that expertise, but not a lot."

A genial, bespectacled fellow who sometimes wears a white lab coat and spouts medical terminology, Bruley, 57, could pass for a family doctor. But patients are unlikely to hear his name, let alone meet him. Hired in most cases by hospitals, he arrives soon after a medical mishap to conduct interviews and weigh the evidence—though often he can solve a problem by phone. He



PHOTOGRAPH BY: CLEM MURRAY / STAFF PHOTOGRAPHER

Mark Bruley, a premier investigator of medical accidents, also is an accomplished magician and a devotee of land sailing.

also advises regulators and law enforcement, here and abroad.

If there is fault to be found, he will try to find it, though he prefers not to put it that way. His goal is not to point fingers, but to improve medical devices and procedures and, thus, patient safety.

He saw that the burned baby had been receiving oxygen through what is called a single-limb breathing circuit. He found that this had allowed oxygen to build up around the baby's head, beneath the surgical drapes, whereas a double-limb circuit has a Y-shaped valve that would have carried it safely away.

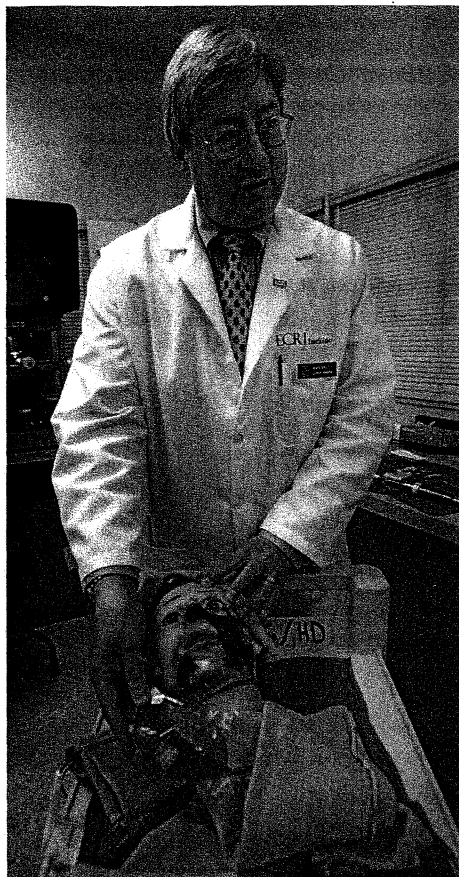
Oxygen is not flammable, but it will make other things burn much faster. In this case, the light, fuzzy hair on the infant's skin caught fire, along with the thin surface fibers on the drapes. Sparks from an electrosurgi-

cal cauterizing probe had ignited the blaze, and in the oxygen-rich environment, it burned with sudden fury.

"The whole thing went up in a flash," Bruley said.

Such investigations are one of many activities at ECRI, housed in a low-slung complex on a wooded Butler Pike campus. Founded in 1968 as the Emergency Care Research Institute, it soon became known simply by its initials—pronounced *ECK-ree*—as the mission grew beyond emergency medicine. The nonprofit, which accepts no funding from device makers or drug firms, evaluates medical technology and procedures for safety, quality, and cost-effectiveness.

A vice president in charge of accident and forensic investigation, Bruley regularly lectures on surgical fires. He estimates that they occur 600 times a year out of 60 million



PHOTOGRAPH BY: CLEM MURRAY /
STAFF PHOTOGRAPHER

Mark Bruley uses a mannequin in his lab to explain his findings in a surgical fire that burned a patient around the oxygen mask. He is a vice president of the nonprofit ECRI Institute in Plymouth Meeting.

operations, causing 20 to 30 serious injuries, virtually all preventable. One of his key recommendations: When possible, give patients regular air instead of 100 percent oxygen.

Bruley started at ECRI in 1975, after graduating from Temple University, but his first appreciation for medicine had come much earlier. He had surgery to correct a childhood condition known as "funnel chest," in which his rib cage pressed on his heart.

"My first memories of life are being in the hospital as a patient, having my chest cut open," Bruley said. "When you're 3 1/2 and alone in a hospital, it instills in you a certain sense of focused memory and independence."

He got to hold his first brain at age 6. That happened when a playmate's

father, a Johns Hopkins University doctor, invited the boys to his lab.

An electronics buff, Bruley earned his ham radio license in sixth grade. And like many who become engineers, he was often taking things apart.

Now he does so for a living. His lab is full of devices that didn't work right—sometimes due to a flaw in the equipment, though more often because of the way it was used. Endoscopes that were not disinfected. A type of catheter that delivered too much microwave energy to the prostate, with disfiguring results. A cranial drill bit that, when wrongly assembled, would penetrate the brain.

Near his lab is a fully loaded machine shop that would rev any tinkerer's engine. A milling machine, two lathes, drill presses, and industrial shears sit alongside custom analytical equipment—such as a dynamometer for testing motorized scooters, and a giant contraption for dropping large medical devices to see how easily they break.

Then there's a vibration table, which Bruley and colleagues once used to simulate the flight of a C-130 transport plane. The goal was to learn why an anesthesia machine had become miscalibrated in flight, later causing a fatal overdose. ECRI's finding, after such a machine was shaken for a few minutes: The vibrations were of just the right frequency to loosen a critical screw.

Despite the grim incidents he encounters, Bruley maintains an optimistic, can-do attitude. Yet he is down to earth. "Compared to his brain, he's not snobby at all," said David Darnel, a biomedical engineer at Stony Brook University Medical Center in New York.

Bruley also has a fun streak. He is an accomplished magician, performing as Magic Marcus, and is a devotee of land sailing. He uses the machine shop to build some of his rigs, equipped with giant kites that propel him across the dry beds of the Mojave Desert. He recently converted one to run on ice.

Asked if he couldn't just buy an ice boat, the engineer took mild offense: "What's the fun in that?"

Someone once called him Sherlock Holmes, which Bruley found amusing enough that he taped up a small silhouette of the detective at his office. Fittingly, on one investigation in England, a colleague who worked with him was named Watson.

Without question, he could make more money in the private sector than at a nonprofit, and there have been offers. But Bruley said he had never had the urge because he could have a greater impact on patients, and achieve more personal fulfillment, at ECRI.

"I've been constantly learning since I got here," he said.

Though his findings can be unfavorable to hospitals or device makers, he and his colleagues have earned respect.

"Some of the manufacturers get mad as hell at them, and my impression is that they don't really care," said Atlanta lawyer Judson Graves, who has represented device makers and hospitals.

Ken Drake, a lawyer who represented Cedars-Sinai in the case of the baby who caught fire, said the hospital had welcomed Bruley's results.

When the case went to trial, in 1992, a plaintiff's attorney argued the hospital was at fault because the surgery had occurred in a patient-care room, not an operating room.

But this was irrelevant, Bruley testified. The breathing circuit led to the fire, and the responsibility for that lay with the anesthesiologist, he said. That man was not a hospital employee, and the case settled for less than the plaintiffs had sought, said Drake, the attorney. (The anesthesiologist is dead.)

"Mark had a way of being very scientific in his presentation," Drake said. "You really had the sense he was an objective scientist, as opposed to a highly partisan expert."

Bruley does not seek out court cases—in fact, he and his ECRI colleagues turn most of them down.

Unless, of course, there is new knowledge to be gleaned. Or the chance to take something apart.

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