News: Botched execution could lead to legal challenges in death penalty states (*BMJ* 2014;348:g3064)
Editor's choice: Medicalizing execution (*BMJ* 2014;348:g306)
News: New drug combination for execution in US leaves hospitals in short supply (*BMJ* 2014;348:g384)
News: WMA says doctors must not prescribe drugs for execution (*BMJ* 2012;345:e707)

THE SLOW DEATH OF LETHAL INJECTION

The medicalisation of execution, once seen as the solution to concerns about the death penalty, is now threatened by a drugs embargo, as grimly illustrated by the botched execution of an Oklahoma inmate last week. **Owen Dyer** reports

"Please—Please—Please HELP… this system failure—a mistake—1 carton of 20 vials—is going to affect thousands of Americans." This email, sent last November from a Louisiana pharmaceutical distributor to Missouri's department of corrections, eventually persuaded Missouri to relent and return the propofol it had bought against the wishes of the drug's German manufacturer Fresenius Kabi. Missouri's governor Jay Nixon ordered the department to find other execution drugs, and the US narrowly escaped a catastrophic embargo of its most important anaesthetic. American hospitals will still have the drugs they need to do their job. But American executioners may not, in the face of a remarkably unanimous refusal to sell from both European and US drug makers.

It is now three years since an EU ban effectively deprived the US of sodium thiopental, the key drug in the three drug protocol used in most executions since lethal injection began in 1982.

States have been driven to experiment with untested combinations, such as the cocktail tried last week on Oklahoma murderer Clayton Lockett, who awoke 16 minutes after being injected with midazolam only to die from a heart attack after the execution had been called off.

In the frantic search for drugs, states have resorted to desperate and sometimes disreputable methods. Prison authorities have bought drugs using employees' credit cards and submitted prescriptions under employees' names. Louisiana declared itself ready to execute a prisoner, only to have a court subpoena reveal that its drugs had expired.[1]

Kentucky, Tennessee, and Georgia had to hand over their supplies of sodium thiopental to the Drug Enforcement Administration after it emerged that they had been illegally imported. At least two US states, Georgia and Arizona, purchased unapproved sodium thiopental from Dream Pharma, a UK distributor that operates out of the back of a London driving school. Arkansas, California, and Nebraska have also purchased unapproved thiopental from abroad. All seem to have paid many times the market price.

The US Food and Drug Administration initially chose to overlook these illegal importations, but a federal appeals court ordered the agency to enforce its regulations. The foreign supply window has effectively closed.

Fourteen states have now adopted pentobarbital as a first choice or back-up execution drug. But its maker, Lundbeck, restricted the supply in 2011 to deny it to executioners. Unable to obtain the manufactured product, states began buying pentobarbital from compounding pharmacies.

Compounding the problem

"It seems unlikely that this is going to be a long-term solution," says Deborah Denno, professor at Fordham University School of Law. Imminent federal regulation of compounding pharmacies could seriously hinder the fly by night trade in execution drugs.

The Apothecary Shoppe, a compounding pharmacy in Tulsa, Oklahoma, was named in court papers as a supplier of pentobarbital to several states. But a federal appeal by condemned Missouri murderer Michael Taylor ended in February with the Apothecary Shoppe agreeing not to provide pentobarbital for his execution. For three previous executions, a Missouri corrections official had travelled to Oklahoma, paid in cash, and carried the controlled substance back across state lines. Taylor's lawyers successfully argued that this was illegal.

They also criticised Missouri's back-up protocol using the benzodiazepine midazolam and the opioid hydromorphone, pointing to Ohio's January execution of Dennis McGuire, who raped and murdered a pregnant newlywed in 1989. McGuire was the first prisoner to be injected with a midazolam/hydromorphone combination. Witnesses said he panted for air and writhed for 10 minutes,

EXECUTION DRUGS

Lethal injection chamber, South Dakota

AMBER HUNT/AP/PA

Sodium thiopental—A short acting barbiturate general anaesthetic used to cause unconsciousness in all lethal injections from the first, in 1982, until 2011. For most of that period it was the first drug injected in the standard three drug protocol. Facing legal challenge, some states switched to using thiopental alone to induce anaesthesia and cause death. But US production ceased in 2009, and the EU barred sales to the US in 2011. No state retains a supply today

Pancuronium bromide—A curare-type neuromuscular blocking agent and the second drug in the old three drug protocol. Pancuronium was intended to stop breathing and induce paralysis. It was under increasing legal challenge, as opponents argued that if thiopental failed to induce anaesthesia, pancuronium would cause great suffering but prevent the prisoner from showing it. The UK and several other European countries ban its export to the US

Potassium chloride—A metal halide salt that, in large doses, rapidly stops the heart. It was the third drug in the standard three drug protocol but has become less relevant as states move towards anaesthetic only protocols

Pentobarbital—This short acting barbiturate, widely used in animal euthanasia, was prison authorities' preferred replacement for thiopental, administered alone in a lethal dose. Principal maker Lundbeck has put the manufactured product out of reach of US corrections departments.

Propofol—This short acting hypnotic/amnestic agent is widely used in US hospitals, and when Missouri announced plans to adopt it as an execution drug, an intense backlash from the medical community forced them to rapidly change course.

Midazolam—This short acting benzodiazepine has recently become the drug of last resort for states unable to find pentobarbital. It has been used on three occasions, most recently in Oklahoma's botched execution of Clayton Lockett

Hydromorphone—A derivative of morphine, the analgesic hydromorphone has been used once in lethal injection, in Ohio's controversial execution of Dennis McGuire

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HEALTH RELATED LIFESTYLES OF CHILDREN: GETTING BETTER?

John Appleby investigates whether the statistics support media reports that children's health is on a downward spiral

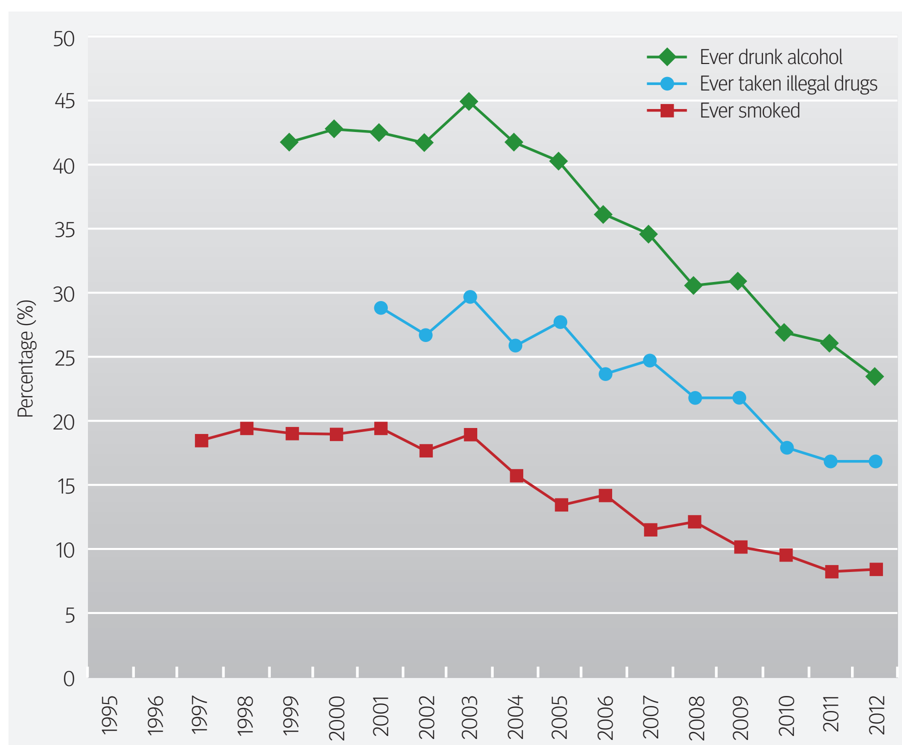

Fig 1 | Percentage of children (2-15 years) in England who have ever drunk alcohol, taken drugs, or smoked cigarettes[5 6]

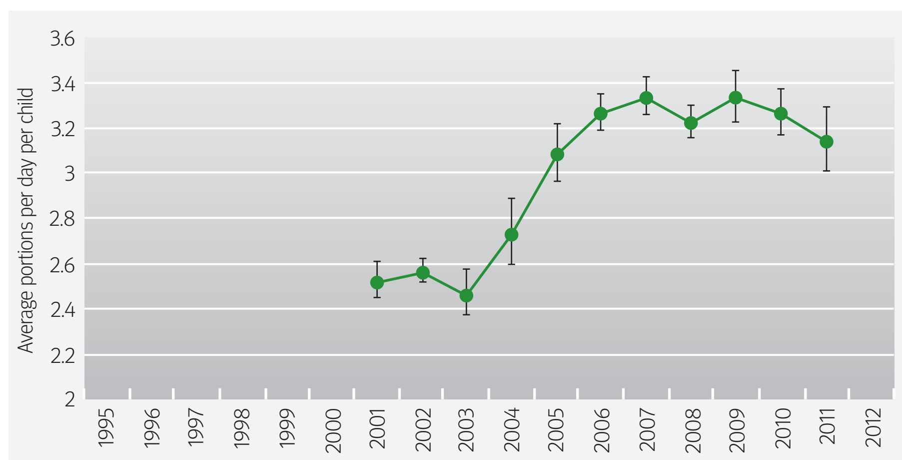

Fig 2 | Average portions of fruit and vegetables consumed per child (2-15 years) each day, England, 2001-11[5]

Last month the chief medical officer for England, Sally Davies, published her annual report on the state of the public's health.[1] This followed a companion report published in October 2013 that focused on the health of children.[2] Naturally, the review expresses concern about the physical and mental health of children, both in the aggregate and particularly in its unequal distribution across social classes and geographical areas. A "prevention versus cure" metaphor often favoured by public health professionals is that rather than wait to fish out bodies from the stream to cure people of their illnesses, better to go up stream and prevent people falling in in the first place. Children are effectively the "upstream" versions of adults, so there is a strong public health argument for investing in healthy behaviours in children. But how has children's health, and particularly their health related lifestyle behaviours, changed over time?

Given media reports such as those about 10 month old children being treated by the NHS for obesity[3] or children under 11 being admitted to emergency departments after drinking too much alcohol[4] it can seem that today's children are on a downward health spiral. But a look at some health and health behaviour trends suggests a different picture.

On smoking, the proportion of children in England aged between 2 and 15 who have ever smoked, for example, has fallen in the past decade from nearly one in five (19.1%) in 2003 to just 1 in 11 (8.7%) in 2012 (fig 1). And the proportion who have ever drunk proper alcohol has nearly halved—from 45% to 23% (fig 1). On fruit and vegetables, consumption is up significantly since 2001, from an average of around 2.5 portions a day per child, to around 3.3 in 2007—although it has levelled off since 2005 (fig 2). It also appears that the mean body mass index of children stopped increasing by 2004 and since then children may be becoming slightly lighter

SUE OGROCKI/AP/PA

Death penalty opponents outside the Governor's mansion in Oklahoma City, in January

and was pronounced dead at 24 minutes. Ohio suspended executions while it reviewed its new protocol, concluding last week that McGuire's execution was "conducted in a constitutional manner." However, Ohio will in future increase the dose of midazolam/hydromorphone.[2]

Midazolam the weakest link

Pentobarbital, where obtainable, is seen as the drug most likely to survive court challenges. Midazolam seems vulnerable, particularly in the wake of last week's botched execution in Oklahoma. Pentobarbital is commonly used for animal euthanasia. It is also used in Oregon's assisted suicide programme, although not with uniform success—at least one patient has awoken after taking a supposedly lethal dose.[3]

Midazolam is a sedative, not normally used to achieve surgical anaesthesia. The other drug used by Ohio in McGuire's execution, hydromorphone, is at the centre of America's prescription opiate abuse epidemic, and involved in thousands of poisonings every year.

"In the old days when they could get general anaesthetic it looked like anaesthesia, a comatose state," said Jonathan Groner, professor of clinical surgery at Ohio State College of Medicine. "If you kill someone with an overdose of narcotics, they die like heroin addicts die, which is not pleasant."

McGuire's family, upset by the execution, are suing the state and the drugs' maker, Hospira, which had not foreseen that midazolam and hydromorphone would be used as execution drugs. Both drugs are now on Hospira's restricted access list.

The dose of midazolam given to McGuire, 10 mg, was only twice what a man of his weight might receive for conscious sedation during colonoscopy. The day after his execution Ohio proposed a fivefold increase in midazolam dose to 50 mg, which is the dose used in Oklahoma's botched execution of Clayton Lockett. Florida, by contrast, has specified 500 mg of midazolam in its protocol.[4]

How are such discrepancies possible? "Because they're playing at science, at pharmacology," says Joel Zivot, anaesthesiologist at Emory University Hospital in Georgia. "They don't know what they're doing, but they won't accept that they don't know."

White coat, black hood

Jay Chapman, the Oklahoma medical examiner and pathologist who invented the three drug protocol used until 2011, believed that no ethical barrier prevented physicians from administering lethal injection and declared his own willingness to do so. However, in 2006 he said he "never knew we would have complete idiots injecting these drugs . . . which we seem to have."

The anonymous staff who execute prisoners in the US have wildly varying levels of medical expertise. Many states make no effort to verify unconsciousness; others use basic methods such as lifting the eyelids. Bispectral index monitors are unavailable—their makers refuse to sell for executions.

States have been driven to experiment with untested combinations, such as the cocktail tried last week on Oklahoma murderer Clayton Lockett

Denno says that most lethal injections are performed by prison staff with some paramedic training but that doctors' participation is greater than generally believed. Georgia and North Carolina have taken legal steps to protect participating doctors from censure by their disapproving state medical boards.

In 2006 a court ruled Missouri's supervising execution doctor incompetent and barred him from further participation, ordering the state to find an anaesthesiologist. The requirement was dropped after Missouri wrote to 298 anaesthesiologists and found none willing to help.

"Lethal injection was not anesthesiology's idea," remarked Orin Guidry, president of the American Society of Anesthesiologists. "The legal system has painted itself into this corner and it is not our obligation to get it out."

Anaesthesiologist Joel Zivot echoes this sentiment. "Speaking as a physician, I just want to say: Leave my stuff alone. Leave my profession out of it. I've had patients say to me: 'Wow, is this the stuff they kill people with?' I think that the state is impugning me, making it harder for me to do my job."

Back to the future

State prison authorities have proved surprisingly short of weapons to fight the embargo—many have difficulty even producing a signed doctor's prescription for execution drugs. This March, Delaware became the first state to publicly abandon efforts to replace its expired supplies. Arkansas's attorney general last year called the state's capital punishment system "completely broken." Citing lack of drugs and of willing medical staff, he said, "It's either abolish the death penalty or change the method of execution."

Many states still have the legal option of electric chair, firing squad, or hanging, and initiatives are now cropping up in state houses to return to more violent but swifter methods. None has yet passed, but these methods are not so far behind us as some imagine. The last execution by firing squad was in 2010, the last by gas chamber was in 1999, and the last hanging occurred in 1996. The last use of the electric chair was in 2013 in Virginia.

A national poll conducted after McGuire's execution found widespread support for the death penalty at 62%, with only 26% against. But when asked about specific methods, only lethal injection, supported by 57%, had majority support.[5]

While state corrections authorities cling to lethal injection, public advocates of the death penalty have already moved on. Michael Rushford, president of the Criminal Justice Legal Foundation, believes the medicalisation of death was a wrong turn.

"Nitrogen is an inert gas. You could put someone in a room with Ethel Merman songs and turn on the gas and they would just go to sleep. You could just lower the air pressure in a room, and—as I learned as an Air Force navigator—they would quickly fall asleep. Likewise, carbon monoxide is dangerous precisely because victims fall asleep without noticing. Rather than involve a quasi-medical procedure, training people to insert needles, a much more peaceful passing would occur with some of these methods. You eliminate all the medical questions. No doctor is going to have his career at risk; no drug company will be picketed or boycotted."

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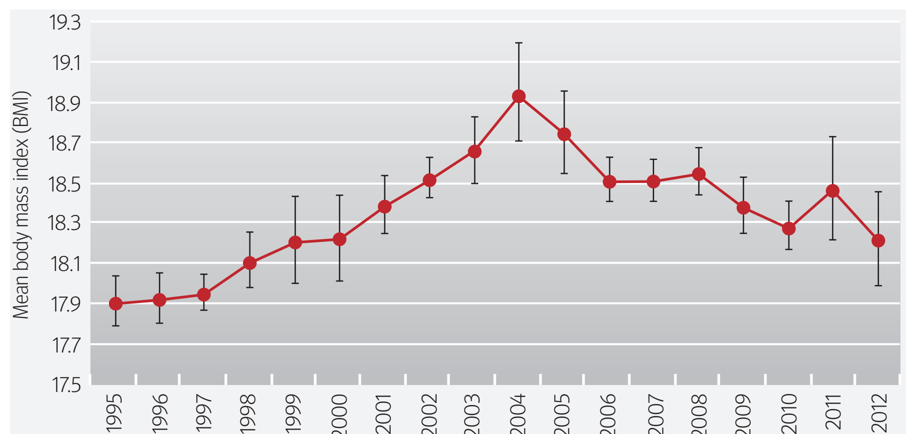

Fig 3 | Mean body mass index of children aged 2-15 in England, 1995-2012[5]

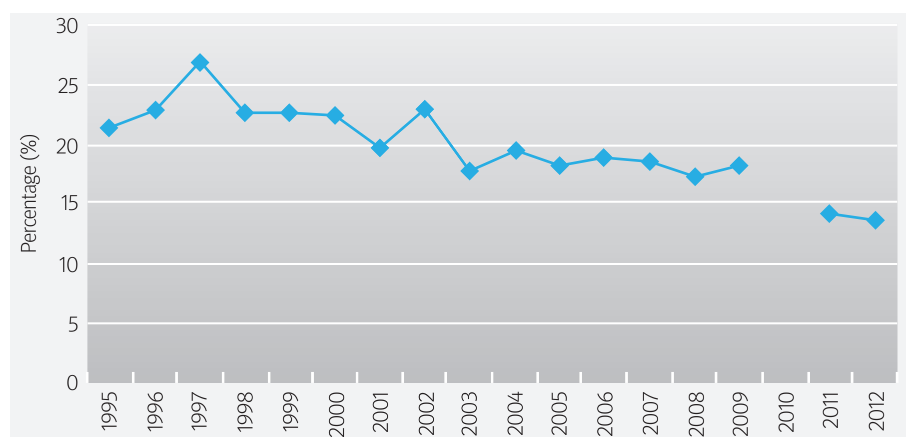

Fig 4 | Trends in percentage of children aged 2-15 with longstanding illness in England, 1995-2012[5]

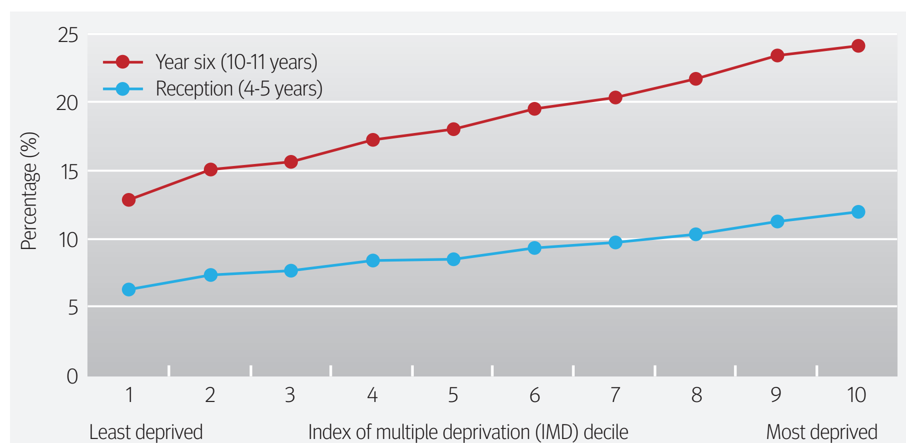

Fig 5 | Percentage of children in national school survey who are obese by socioeconomic deprivation[7]

(although levels of obesity remain relatively high) (fig 3). And on one measure of health at least—longstanding illness—there are also improvements, from around one in five children in 1995 to just under one in seven in 2012 (fig 4).

It is hard to know precisely what is driving these trends. The decreasing trends in children ever having taken other drugs shows that they are not simply switching their choice of stimulant, although reductions may be in part due to changes in children's attitudes to reporting drug use.

Why children decide to drink alcohol or smoke or take (other) drugs is complex and will include among other things, access to alcohol and cigarettes (governed by a combination of economics and law), the impact of advertising, the social culture of peers, family attitudes, and, we presume, public health messages. Like the joke about the effectiveness of advertising (half works, half doesn't, but we don't know which half) it's not clear which of these (or other) factors singly or in combination should take the credit for these trends.

However, these aggregate trends hide a key concern raised by the chief medical officer's reports, which is inequalities in the distribution of health (and the causes of ill health). We may be doing better overall, but not for some groups of children. In 2012 for example, twice the proportion of children in the most deprived areas of England were obese compared with those in the least deprived areas—24% compared with 12% among 10 to 11 year olds, for example (fig 5). Shifting the whole distribution in the right direction seems somewhat easier than reducing the variation.

What is true for adults[8]—that lifestyle behaviours are clustered in different population groups—is also true for children.[9] Some children are at high risk of multiple poor health related lifestyles. Looking at behaviours in isolation misses that. Better to pay more attention to how different groups of children engage in different combinations of behaviours—that means refocusing on their wider circumstances and the context in which they live their lives, at school and at home.

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