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Dealing with uncertainty in medical murder cases: the Royal Statistical Society calls for more statistical expertise in the investigation of medical misconduct

The Royal Statistical Society (RSS) has published a report tackling statistical bias in criminal trials where healthcare professionals are accused of murdering patients. Following several high-profile cases where statistical evidence has been misused, the learned society calls for all parties in such cases to consult with professional statisticians and use only expert witnesses who are appropriately qualified.

Suspicions about medical murder often arise due to a surprising or unexpected series of events, such as an unusual number of deaths among patients under the care of a particular professional. The RSS has two major concerns about use of this kind of evidence in a criminal investigation: first, over the analysis and interpretation of such data, and secondly over whether it can be guaranteed that the data have been compiled in an objective and unbiased manner.

When interpreting such data, investigators need to consider whether the deaths that prompted the investigation could have occurred for reasons other than murder, in addition to considering whether, if murder was the cause, the person under suspicion is responsible. The report illustrates the statistical challenge of distinguishing event clusters that arise from criminal acts from those that arise from other causes or coincidentally by chance.

Such possible causes include seasonal or time-of-day factors, changes in the patient population towards sicker patients, changes in staffing levels, administrative procedures, or treatment regimens. For a specific example, in some settings most deaths naturally take place in the morning, as opposed to at night as might be expected. Nurses whose shift patterns typically include morning duties will then automatically experience higher rates of death on their shifts. Such factors are often overlooked, even by the defendants themselves.

Regarding the assessment of chance variation in the data, the report calls for more care to be taken by experts in explaining the proper interpretation of *p*-values (the probability that the observed number of deaths would occur by chance) and urges experts to avoid drawing erroneous inferences from them. This was the case with Dutch nurse Lucia de Berk who was eventually acquitted in 2010. A criminologist in the original trial had mistakenly calculated the probability of so many deaths occurring when de Berk was on duty as one in 342 million, when the correct figure may have been one in 25.

The RSS's concerns about the compilation of the data used in such investigations are that attention is rarely given to ensuring that unconscious bias has not influenced the selection of cases. It is well understood that such innocent cognitive biases are prevalent throughout society, and their effects can only be eliminated by strict adherence to practices such as blinding. This is routinely used for example in medical research, where investigators are prevented from knowing about treatment assignments when compiling data for analysis. In the medical misconduct setting, investigations should be supervised by expert panels independent of both the suspect and their employer.

Stian Westlake, Chief Executive of the Royal Statistical Society, commenting on the report, said: "Cases where a healthcare professional is accused of murdering their patients are extremely complicated with many potential biases at play.

"We have seen cases across the world of people wrongfully charged based on incorrect statistical analysis. We're calling for better collaboration between the legal and statistical communities to prevent such miscarriages of justice happening in the future."

Prof Christl Donnelly, RSS Vice-President for External Affairs, said: "Statistical evidence in these types of cases can be incredibly difficult for legal professionals to interpret. The consequences of this can be devastating, but we hope the guidance we have set out will be of some help in dealing with these challenges."

Notes to editors:

Case studies

- **The case of Lucia de Berk**
  In 2004, Dutch paediatric nurse, Lucia de Berk was convicted of seven murders and three attempted murders of children under her care. During her original trial, a criminologist presented statistical evidence stating that the probability of so many deaths occurring while de Berk was on duty was only one in 342 million.
  Prominent statisticians came forward to argue that the incriminating statistic was based on an over-simplified and unrealistic model, biased data collection, and a serious methodological error in combining p-values from independent statistical tests.
  The case was later re-tried and de Berk was acquitted.
- **The case of Jane Bolding**
  In 1988, Jane Bolding, an American nurse was prosecuted for serial murder of patients. The key evidence against Bolding was the high incidence of cardiac arrest during periods when she was on duty. Evidence suggested that she had been the primary nurse on duty when 57 heart attacks occurred, while the number during comparable periods had never exceeded five.
  A judge found the prosecution's statistical evidence insufficient to warrant a conviction, saying that the evidence at most placed Bolding at the scene of the deaths.
- **The case of Harold Shipman**
  The case of Harold Shipman is a well-known example of where medical professionals have intentionally harmed their patients. In 2000, Shipman was found guilty of the murder of 15 patients under his care, with investigators suspecting the real figure to be much higher. In light of this, there were calls for improved monitoring of adverse medical outcomes, with statisticians arguing that if this had been in place, the lives of some of Shipman's victims could have been saved.
- The Royal Statistical Society (RSS), founded in 1834, is one of the world's most distinguished and renowned statistical societies. It is a learned society for statistics, a professional body for statisticians and a charity which promotes statistics, data and evidence for the public good. Today the RSS has around 10,000 members around the world. rss.org.uk @RoyalStatSoc
- The *'Healthcare serial killer or coincidence?'* report was produced by the Statistics and the Law Section of the Royal Statistical Society. The group evolved from a working group of the same name set up in early 2000s after the Society wrote to the Lord Chancellor and made a statement setting out concerns around the case of Sally

Clark, including miscalculation of the probability of two cases of Sudden Infant Death Syndrome in a family. Read more about the Section here.

- The full report as well as a summary version are available on request.