

## Statistical issues in Serial Killer Nurse cases

Richard D. Gill†

*Mathematical Institute, Science Faculty, University of Leiden, Netherlands*

E-mail: gill@math.leidenuniv.nl

Norman Fenton, Martin Neil

*School of Electronic Engineering and Computer Science, Queen Mary, University of London, UK*

*Agema Ltd, Cambridge, UK*

E-mail: n.fenton@qmul.ac.uk; m.neil@qmul.ac.uk

David Lagnado

*Department of Experimental Psychology, University College London, UK*

E-mail: d.lagnado@ucl.ac.uk

**Summary.** We discuss statistical issues in cases of serial killer nurses, focussing on the Dutch case of the nurse Lucia de Berk, arrested under suspicion of murder in 2001, convicted to life imprisonment, but declared innocent in 2010; and the case of the English nurse Ben Geen, arrested in 2004, also given a life sentence. At the trial of Ben Geen, a statistical expert was refused permission to present evidence on statistical biases concerning the way suspicious cases were identified by a hospital team of investigators. The judge ruled that the expert's written evidence was merely common sense. An application to the CCRC to review the case was turned down, since the application only presented statistical evidence but did not re-address the medical evidence presented at the original trials. This rejection has been successfully challenged in court, and the CCRC has withdrawn it. The paper includes some striking new statistical findings on the Ben Geen case as well as giving advice to statisticians involved in future cases, which are not infrequent. Statisticians need to be warned of the pitfalls which await them. The paper is dedicated to Florence Nightingale (b. 20 May 1820 in Florence, Italy) on the occasion of her 200th birthday.

*This version:* Friday 14 February, 2020.

*To be done:* add short appendices with critical literature surveys on the phenomenon of HCSK (health care serial killers) from viewpoint of epidemiology from forensic psychology/criminology, and from the Bayesian view, both naïve (chain rule) and sophisticated (Bayes nets).

*Keywords:* Clusters of unusual events; Baader-Meinhof phenomenon; Munchausen syndrome by proxy; confirmation bias; health care serial killers; miscarriages of justice; forensic statistics

†Corresponding author

## 1. Introduction

In 2003, the Dutch nurse Lucia de Berk was given a life sentence (and in the Netherlands, the word “life” needs to be taken literally) for a series of murders at several hospitals in the Hague. Following the unexpected death of a patient under her care, her hospital had sent her on indefinite leave in September 2001, and she was arrested under suspicion of murder in December of the same year. The decisive evidence against her at her initial trial was the results of a statistical analysis of roster data provided by the hospital. Statistician H. Elffers argued that Lucia’s presence at so many “unexplained” or “unexpected” medical incidents could not be due to chance.

Some time in 2006, doubts were publicly raised by a medical doctor Metta de Noo and her brother, philosophy of science professor Ton Derksen (who incidentally got his PhD in Oxford with a thesis entitled “Probability, chances and belief”), as to the safety of the conviction. In the meantime, the case had been through a higher court and finally to the supreme court, and Lucia’s conviction was now definitive, unless, of course, entirely new evidence came up. The word entirely needs to be underlined: at that time, in the Netherlands, new scientific insight concerning the interpretation of existing factual evidence was not admitted by the supreme court as reason to re-open a closed case. In fact, this case, together with several other famous miscarriages of justice at around the same time, later forced the supreme court to become a little more flexible.

A long struggle led by de Noo and Derksen then ensued, pushing for a retrial, and a review of Elffers’s original statistical analysis was an important part of this. Though the focus of the case had shifted to the medical evidence, the view of the public was still dominated by Elffers’ probability (in fact, a  $p$ -value) of one in three hundred and forty two million. Publications and talks and media appearances by myself gave me some notoriety.

No doubt because of this, in 2014 one of the authors (R.D. Gill) was approached by the defence team of one Ben Geen, an English nurse, who had been convicted back in 2006 for deliberately harming many patients, leading to the deaths of several.

In this paper we want to discuss statistical aspects of both cases. We are fairly certain that Ben Geen’s conviction was unsafe, in other words, that it was not proven beyond reasonable doubt that he was guilty. Some of the authors are in fact personally convinced, at the moment of writing, that he was innocent, but in this paper, of course, we restrict ourselves to (in a broad sense) statistical issues, which (it seems to us) these two cases, and perhaps more importantly, *many others*, have in common. Not being lawyers, we do not claim that these statistical issues alone are enough to make the present conviction unsafe, though some UK legal specialists do, it seems to us forcibly, make this argument. The reader interested in medical and toxicological aspects of the Ben Geen case will easily find a wealth of material on internet.

## 2. The case of Lucia de Berk

The case of the Dutch nurse formerly known as “Lucia de B.” starts with three  $2 \times 2$  tables, see Figure 1. The data can also be found in a recent paper Gill, Groeneboom and de Jong (2018). It differs to that found in some earlier journal publications by correction of unimportant misprints. These particular numbers were statistically analysed and

JKZ		Incident in shift		
		Yes	No	
Lucia on duty	Yes	8	134	142
	No	0	887	887
		8	1021	1029

RKZ-41		Incident in shift		
		Yes	No	
Lucia on duty	Yes	1	0	1
	No	4	361	365
		5	361	366

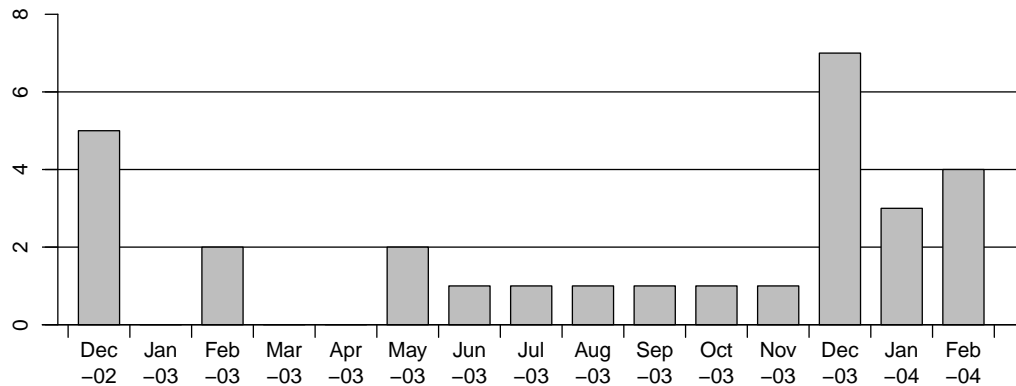
RKZ-42		Incident in shift		
		Yes	No	
Lucia on duty	Yes	5	53	58
	No	9	272	281
		14	325	339

Fig. 1. Roster data from the case of Lucia de B.

interpreted for the court in 2002 by a certain Henk Elffers, who had been contacted in 2001 by police investigators at the beginning of what became a ten year saga. His reports to the court, Elffers (2002a) and Elffers (2002b), have been made available for scientific research. Elffers had been educated 20 years before that as a mathematical statistician but later moved to empirical social-economic research and from there (via tax-evasion) to law and criminology.

During nearly a year ending in September 2001 when police investigations started, on a medium care ward at the Juliana Children’s Hospital (“JKZ”) in the Hague, there were in total 1029 (3 × 343) 8-hour shifts (3 shifts a day, 7 days a week). In 8 of them, an “incident” occurred. All 8 in the shifts of a certain nurse called Lucia. Several years earlier, at another hospital, the Red Cross Hospital (“RKZ”), during the same four months in two intensive care wards (Wards 41 and 42; the data from ward 42 misses 9 days at the beginning and end of the 4 month period) there were 5 and 14 incidents respectively. Lucia was only on duty once in RKZ-41 but on just that one occasion she netted one of the 5 incidents! She mainly worked on Ward 42, where she netted disproportionately many of the 14 incidents (she had one third of the incidents in only one sixth of the shifts). Does one need a statistician to interpret it to the board of judges of a criminal court where Lucia is being tried for serial murder? The data speak for themselves. This was certainly the opinion of the judges at Lucia’s appeal in 2004: they wrote at the beginning of their summing-up “a statistical calculation of probability plays no part at all in our [guilty] verdict”. Lucia was convicted “solely on the grounds of irrefutable and scientific medical evidence”. However, the rest of their more than 100 page summing-up makes it clear that they, and many medical experts too, were already convinced *because of the raw statistics* that Lucia’s presence at so many incidents could not be chance; her mere presence caused them to classify incidents as *inexplicable* and hence *suspicious*. Toxicological evidence concerning one death was then sufficient, by a so-called chain argument (which was in fact an informal Bayesian argument), to turn other deaths and resuscitations into “scientifically irrefutably proven” murders and murder attempts. Lucia was a particularly refined murderer since she continued to brazenly to assert her innocence, and she was so cunning in most cases as to leave no evidence at all [!] of how she had killed her patients.

Do the data speak the truth, the whole truth, and nothing but the truth? No. Lucia’s life sentence for ten murders of children and old people got reversed. At the retrial in 2010, the judges, in their summing up, congratulated the nurses on their devotion and



**Fig. 2.** Admissions to critical care from the emergency department with a diagnosis of cardio-respiratory or respiratory arrest or hypoglycaemia, data: Head Nurse Brock

their professional efforts to save the lives of their patients, lives which (they publicly announced) had been unnecessarily shortened through medical errors. The errors were caused by mis-diagnosis, chaotic management, ignorance of the content of the patients' medical dossiers . . . they were committed by hospital specialists and hospital managers, as is abundantly clear from the medical evidence given at the re-trial.

The key to Lucia's exoneration was the invalidation of the toxicological argument concerning the "trigger-case". We now know that a coincidence of several triggers set off a witch-hunt, followed (as was already noted by observers at the time) by what seemed like a witch-trial. A nurse who stood out from the crowd with a striking appearance, a strong personality, and a colourful (dark?) past was a natural scapegoat for the mistakes being made in a failing hospital department.

### 3. The case of Ben Geen

The data presented in Figure 2 helped get the young English nurse Ben Geen a life sentence for two counts of murder and 15 of grievous bodily harm (a 16th count of grievous bodily harm was not considered proven), in the three consecutive months of December 2003, January 2004 and February 2004. As we wrote before, it seems to us that one can be pretty certain that Ben Geen is innocent of the crimes he was convicted for, just as one can be pretty certain that Lucia is innocent: and for the same reasons. The main reasons have little to do with statistics, but the statistics do tell us something. The main reasons have to do with the social structures in a modern hospital and the facts that (a) sick people do die in hospitals, (b) doctors do make mistakes, (c) top hospital managers and top medical specialists need to protect the reputation of their

hospital. A fourth reason in the Ben Geen case is (d) the so-called “Shipman effect”, connected to the coincidence that the Ben Geen case occurred shortly after the Shipman Enquiry, which blamed health-care administrators for not earlier noticing serial killer doctor Harold Shipman, who, as the enquiry determined, maybe murdered 250 patients in all. Some speak of “Shipman hysteria”.

Obviously, one of the most important factors in a doctor-patient relationship is that the patient has trust in his or her doctor. The medical establishment consequently has a strong interest in patients collectively having trust in doctors, and more generally in their health-care system. Similarly, we need to have confidence in our judges and in our legal systems. The guardians of our legal system strongly believe that our judges and our legal systems must not be seen to make mistakes. Unfortunately, a system which cannot admit to making mistakes can never learn from mistakes and is doomed to repeat them.

Learning from mistakes is good, but a new danger then arises that by learning the wrong lessons from one kind of mistake, one might increase the chance of making the opposite mistake. If the rate of false convictions goes down but nothing else really changes, the rate of false acquittals will go up. The more easily a health-care system goes into alarm-mode because of suspicion that it harbours a health-care serial killer, the more often innocent health-care professionals will trigger an alarm.

This key data-set in the Ben Geen case was later presented as evidence to the court by Michelle Brock, head-nurse of the Accidents and Emergency department where Ben Geen worked, at Horton General Hospital, a rather small hospital in the provincial market town of Banbury in North Oxfordshire. Together with a dossier of perhaps 30 incidents all from December 2003 onwards, it had initially been compiled in great haste before the case was reported to the police. Michelle and some colleagues based their work on patient records and nurse attendance records at the hospital, *looking only at what happened during Ben's shifts*, their investigation triggered and guided by recent memory and gossip. Ben, who was a trainee nurse, had won a higher qualification at the beginning of December, allowing him to work under less supervision than before. The final trigger for their investigation had been two sudden and surprising collapses of patients who had just entered Accident & Emergency (A&E, also often referred to as ED: Emergency Department) on Thursday 5 February. Ben had reported sick on Friday, and had had a free weekend after that. He was arrested on Monday evening, 9 February 2004, when he came in to work to do a night shift. That is only one third of the way into the last bar of the bar-chart. The bar-chart was also known to the medical experts who were consulted on the 18 individual cases. There seems no doubt that it had a big impact on everyone involved in the trial, including journalists covering the trial.

We catch a glimpse from the chart of the fact that a lot of old people and people with existing serious health problems get brought to emergency care during the winter months of December, January and February with acute problems involving heart and lungs (a hot summer is also a danger period). A common diagnosis is cardio-respiratory arrest (the heart has stopped working and consequently the lungs too), much less common is “pure” respiratory arrest (the lungs have stopped working); fairly common is hypoglycaemia: a fall in blood glucose level. It causes fainting; breathing stops or is much suppressed. It can be caused by too much insulin or other glucose lowering diabetes tablets, delaying

or missing a meal, not eating enough carbohydrate, unplanned physical activity, more strenuous exercise than usual, drinking alcohol – the risk of hypoglycaemia increases, the more alcohol you drink. In the bar-chart, nurse Brock has combined the three “standard” categories cardio-respiratory, respiratory, and hypoglycaemic arrest; but what is the correct category is hard to guess when a patient presents (arrives at the hospital). Past medical history, and future medical events will give clues as to what was actually going on. In an emergency situation, past medical history may be unknown.

Hospital nurses and authorities had been worried by the behaviour of the young male trainee nurse Ben Geen already before December 2003. His father was in the army, his mother was a nurse. He had been in the territorial army medical corps, and his ambition was to be qualified and then transferred as a combat medic to a military field hospital in Iraq. He was energetic and very “present”, keen to get action and to get experience. He made some other nurses nervous. They were calling him “Ben Allitt” behind his back, not a kind nick-name, since Bev Allitt is the very well-known name of a pre-Shipman famous English convicted serial killer nurse (an interesting case which might deserve fresh study).

In December 2003 the numbers of patients reaching an overstressed emergency ward in an underfunded minor hospital in a provincial English town, threatened by closure because of its extremely small size, probably understaffed, probably lacking resident consultants in critical specialisms, was bigger than ever. There were a couple of “surprising” events when patients who were initially thought to be in fairly good shape suddenly, and at the time unexplainably, worsened. Ben was usually around when anything happened simply because he was usually around: he was working double shifts in order to gain more and more experience as fast as possible, and also often fell in for absent colleagues.

On Thursday 5 February 2004, at the end of an exceptionally hectic day, a chronic alcoholic diabetic presented himself in the hospital (referred to ED by his doctor), on account of severe gastric pain and vomiting, and suffering fainting fits. Ben took a blood sample. The patient suddenly worsened and later had little idea what else Ben did to him. Ben certainly inserted a *canula* (a tube that can be inserted into the body, for the delivery or removal of fluid or for the gathering of samples) and the patient was transferred to the Critical Care department, CC. The real problem for Ben came later: Ben went home with, unknown to himself (he said), a used plastic needle-less syringe containing some muscle relaxant in his nurse’s smock. Such a syringe is used to administer necessary medications, including a muscle relaxant, through the *canula* prior to inserting breathing and feeding tubes into patients on the way to Critical Care. Ben stayed home sick on Friday, and then had the weekend free. His girlfriend, another nurse, doing the washing, told him off for this (she said) and told him to take it back as soon as possible. So, on Monday evening – with the syringe in his coat pocket – he was met by policemen as he entered the hospital. In some panic (he said) he stupidly further emptied the remaining contents of the syringe into his pocket. Obviously, he tried to harm patients by injecting them with this stuff so that he could then play the hero, helping to resuscitate them! The so-called “Munchhausen by proxy” syndrome.

At his trial, the Crown secured the services of a famous and experienced expert (a highly distinguished professor of Anaesthesiology), who found a number of the events highly suspicious; another confidently swore that never ever in his long experience had

he met with an *unexplained* respiratory arrest. They all agreed on that . . .

Of course they did. All respiratory arrests are “explainable”, though different experts often give different explanations. Actually, whether a collapse is diagnosed as cardio-respiratory, respiratory or hypoglycaemic can be pretty arbitrary. When either heart or lungs get into difficulty, the other organ rapidly gets into difficulties too. Hypoglycaemic arrest (critically low blood glucose levels) always involves breathing problems (you faint when not enough oxygen is reaching your brain) and can trigger further deterioration of heart and lung function. Reduced oxygen levels affect brain, heart, lungs. Muscles burn oxygen, the brain burns oxygen. All arrests are explainable, but the categories which are ticked on forms in the patient’s dossier and in the hospital’s administrative records may differ and may be revised in the light of later events. The categories which tend to be chosen by nurses, doctors and administrators may depend on who is doing it, and may show trends and jumps as time goes by. Just one occurrence of an unusual diagnosis alerts people to its existence, and they start seeing it every day: the well known *Baader-Meinhof phenomenon* or *Frequency Illusion*.

At the time each had actually occurred, each of the 18 cases in the criminal charges against Ben had been “normal”. The last two had surprised some people (certainly not all), but because of earlier suspicion and gossip, they triggered an emergency weekend-long internal hospital investigation, in which more than 30 dossiers of patients who had in recent months gone through Emergency *while Ben was on duty* were combed through, resulting in a dossier of 18 cases to hand over to the police on Monday. In fact the team had access to 4000 patient medical records but were not interested in what happened when Ben was not there. Expert witnesses for the defence later explained how explainable each of the 18 was, though they were honest enough to admit that some cases were too complex to come to any clear conclusion. The prosecution had more expensive and more court-experienced experts than the defence. The prosecution experts were of course specifically hired to point out anomalies in each of the selected 18 cases, and tended to be rather confident of their diagnoses. Prosecution experts are “instructed” by the prosecution, defence experts are “instructed” by the defence. Experts will report what documents they were given to study, and on which their “opinion” is based, but they also tend to receive a lot of further verbal information (much of it hypothetical) about the case from police or prosecutors. That certainly happened in this case.

Ben must have used a myriad of different techniques to cause all these unexplained medical emergencies and in many cases the expert witnesses called by the Crown in fact had conflicting ideas of what he might have done; though they did of course agree that he must have done something. All of the 18 patients were very sick, and what happened to each was what you may well have expected to happen in view of their existing severe and often complex conditions. But sometimes developments are fast, you do not “see them coming”, and so a sudden worsening takes some nurses or some doctors by surprise. People, including Ben himself, did notice Ben often being there when such events took place. He had said, and said it in court again, that he thought he had been jinxed.

Ben’s unemotional and careful account of what he could recall that he had seen and done in each case (he had received military interrogation training), the impression he gave that he knew the law better than the lawyers, an eminent professor’s categorical statement that he had never seen an unexplained respiratory collapse in all his career,

and the smoking gun which was the syringe, together clinched the matter for the jury. It mainly consisted of decent retired folk who had spent most of the trial napping during the presentation of interminable medical evidence (in 18 cases). The judge in his summing up made it very clear what verdict he expected from the jury.

Blood and urine samples from the trigger case showed traces of a muscle relaxant as well as of plenty of sedatives, but unfortunately some of the samples were not dated – one has no idea when they were taken nor by whom! Sedatives and muscle relaxant should have been present. The traces of muscle relaxant were of the same kind as was in the syringe. The consultant anaesthesiologist who had attended to the trigger patient in intensive care said that she had asked (another nurse, later) for a different one. Ben said that he was not told to administer muscle relaxant, so, of course, had not done so. Hospital records were woefully incomplete. Since the earlier cases were not at the time thought to be suspicious, samples of blood and urine had not been taken or had long ago been thrown away.

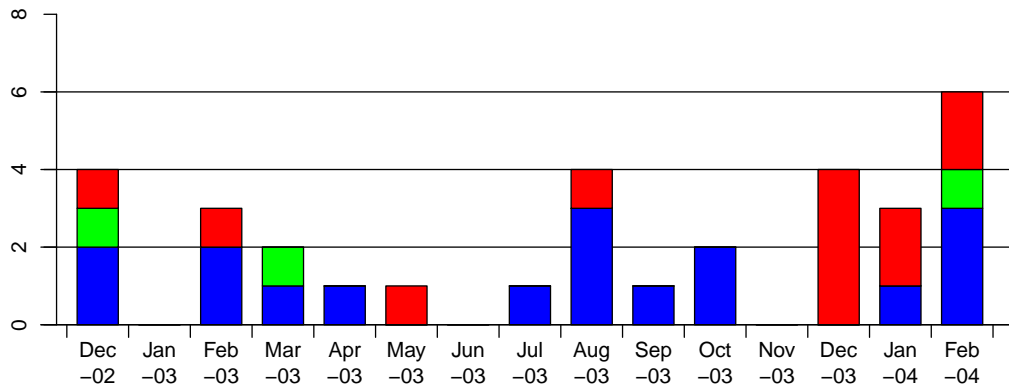
The annual pattern we see in that data can be seen in data which Gill (2014) analysed from many similar hospitals all over Britain. Of course, there is no data whatsoever about unexplained respiratory arrests. The data stored in a hospital database are administrative data. Every event has been put into a pre-existing category with an explanation, because it is not possible to enter it into the data base otherwise. The data in the database determines the fees of the medical consultants (the medical specialists) and the funding of the hospital. The data is not collected for scientific research or forensic investigation.

The three standard categories relevant to this case are *cardio-respiratory arrest*, *respiratory arrest*, and *hypoglycaemic arrest*. We already presented the data supplied to the court by Ben’s head nurse, combining those three categories. Much later, we got from Ben’s hospital the data as presently archived in official hospital records, see Figure 3. It was different! Also, the categories are still separate, and we have data from many more years. The total numbers of relevant cases in December 2002 and in December 2003 are now equal to one another – both an unremarkable 4. Not 5 in 2002 versus an incredible 7 in 2003. The split between categories in the two periods of winter months is markedly different. In winter 2002 – 2003 it is normal, spread out over all three, but mostly cardio-respiratory. In winter 2003 – 2004 almost everything is being categorised as *respiratory*. The total number of cases in January, in both winters, is much less than in adjacent months, this is normal.

Normal case-mix (for the three categories of interest), both in this hospital and in all others (we have similar data from about 40 other hospitals all over England, for the thirteen year period 2000 – 2012), is a mix mainly of cardio-respiratory, with respiratory and hypoglycaemic normally each at roughly a fifth of the level of cardio-respiratory. They are both much less usual, but neither can be called *rare*.

There is also data in the official public enquiry held after Ben’s conviction, held to find out why Ben wasn’t caught earlier and to prevent such a tragedy from ever occurring again. “The number in December 2003 was six and this was only one more than in December 2002”. Two different numbers, yet again. The enquiry suggested that the very large numbers of incidents while Ben was carrying out his attacks might have been expected anyway, due to the winter season, thereby masking incidents caused by Ben. It





**Fig. 3.** Admissions to CC from ED with CR, Hypo or Resp arrest, FOI data, Cardio-respiratory (blue), hypoglycaemic (green), respiratory (red)

did heavily criticise the Emergency department for poor record keeping when updating patient medical notes and very poor registration of patient drug administrations.

**4. Hindsight on Lucia de B.**

What we have showed so far about the Ben Geen case is uncomfortably like the Lucia case. We now know that the Lucia numbers which we showed you are actually *wrong*. Events have been misclassified, some have been shifted from one shift to an adjacent shift. Quite a few have been forgotten – they weren’t “unexplained”, so they weren’t included as “incidents”. Several real incidents (i.e., “incidents” according to the law) have been suppressed. They should have been reported to the health inspectorate, but this wasn’t done. For instance, one incident was really a case of euthanasia deliberately performed by the medical doctors of a child with severe birth defects, which, illegally, was not reported to the inspectorate. The data from JKZ was compiled in a great hurry by someone who was already convinced they were dealing with a serial killer and embarrassed that they didn’t catch her earlier. Lucia was in fact set up, in the sense that the hospital’s clinical director (the head paediatrician) was waiting for a final event to clinch the case she had been building up; she had already compiled the dossiers of selected earlier events.

In hospitals, accidents do happen, but they *must not happen*. The legal and financial consequences are too great. In the Lucia case, perhaps three top medical specialists have knowingly (and under oath) told untruths to the police and to the courts.

There are two other young male nurses in Britain, sitting out life sentences, supposedly for having killed their patients. New medical insight into hypoglycaemia shows

anyone with any intelligence that they are innocent. Yet the criminal justice system is not keen to let convicted people free. There is next to no financial aid for people who need to recruit very expensive lawyers to help them fight an unjust conviction. The national institution (the CCRC) which was set up to deal with possible miscarriages of justice, following a number of scandalous miscarriages, is severely underfunded. The strategy of “the system” is to do nothing and wait for the problem to go away.

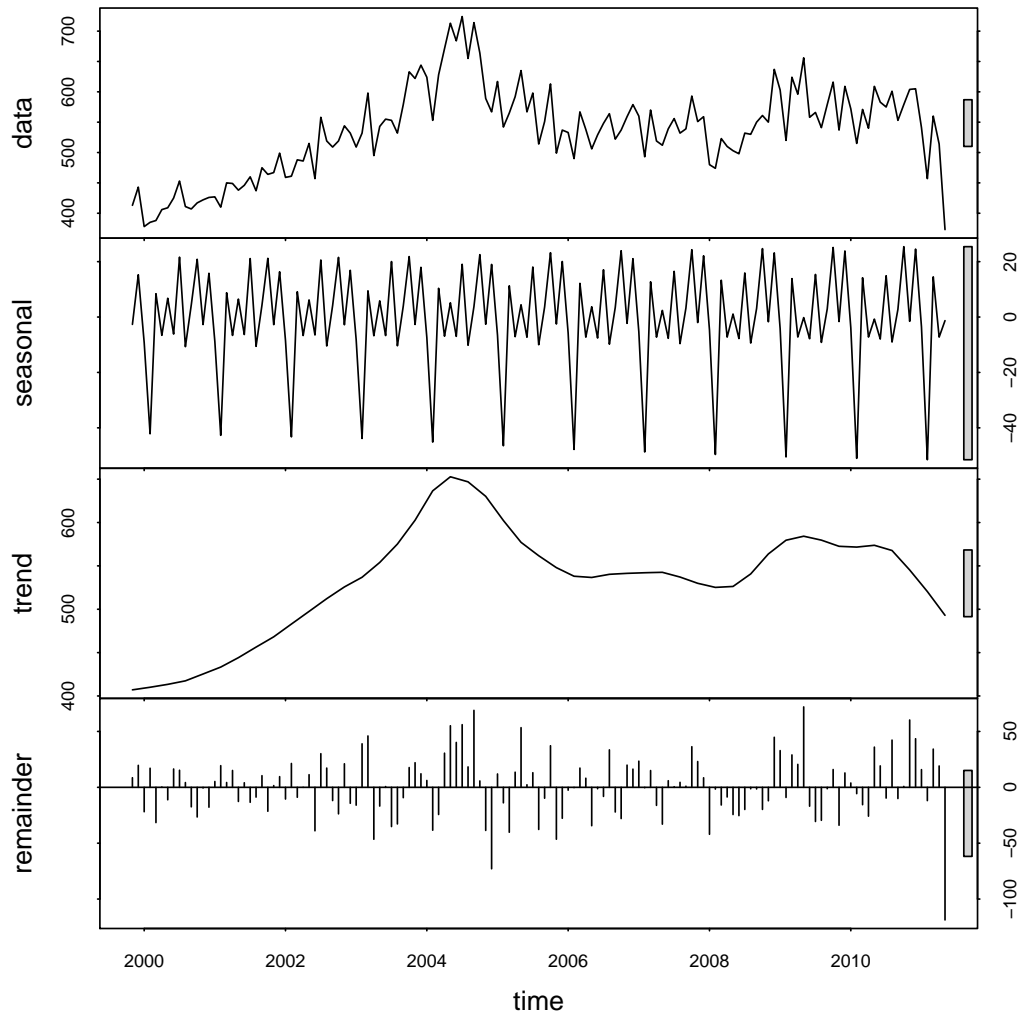
Why, and how, did Lucia get a re-trial in the Netherlands? Answer: Lucia was very, very lucky. There was an almost-inside whistleblower. The sister-in-law of JKZ’s chief paediatrician, Metta de Noo, was a medical doctor, knew her sister-in-law very well, and moreover, Metta’s son and daughter, studying medicine in Leiden, lived with their uncle and aunt in the Hague. Even so, it took a couple of years for the penny to drop.

The “true story” of the Lucia case is still taboo, though the successful 2014 Dutch movie “Accused” did expose fascinating personal aspects of the case, which it could do by changing some of the facts a great deal in order to avoid legal action by main players in the true drama. Earlier, while trying to raise public interest in this case in order to pressure the authorities to take the calls to reopen the case seriously, co-author of this paper R.D. Gill was threatened by a major “intellectual property” law firm in the Netherlands acting on behalf of the management of the hospital JKZ, itself acting on behalf of one of their employees. Leiden University was so kind as to pay for an excellent Leiden-educated lawyer to represent him, but Gill’s lawyer soon advised giving way by removal of some pages from Gill’s university “personal” webpage, since it was going to drag on for a long, long time while costing the university the lawyer’s hefty monthly fee, and all that without a good chance of success. It was a civil case and Gill was harming the reputation, hence the earning power, of wealthy and influential persons, by pointing out a relevant though arguably personal fact about a key medical witness. Journalists today who know the whole inside story still do not write about it. Too many too powerful people are still alive and kicking (Gill hopes to outlive them).

There were many more lucky breaks. Lucia had first experienced some definite bad luck (though nothing like the 1 in 342 million which hit the newspapers) but later some new coincidences put some of the best medical and legal minds in key positions along the tortuous route to a re-trial. “Truth will out”, if you give it a chance, and it was given a good chance. A chance which, we believe, Ben Geen did not yet get.

## **5. New light for Ben Geen**

We will now present some summary statistics based on data obtained from Ben Geen’s hospital which has been available for several years but never looked at before. Instructed by Geen’s defence team, R.D. Gill was asked to answer certain questions about the “normal situation” in hospitals *like* HGH, using data that had been obtained from numerous FOI requests to hospitals all over the country. He did his best to answer exactly those questions and tried to maintain his scientific objectivity by not learning about other aspects of the case. Let’s take a look at the monthly total number of admissions in the emergency room of his hospital over a thirteen year period roughly centred on the critical end of 2003 – beginning of 2004; see Figure 4. We have given this time series to the go-to algorithm in the R package which, in an iterative procedure using



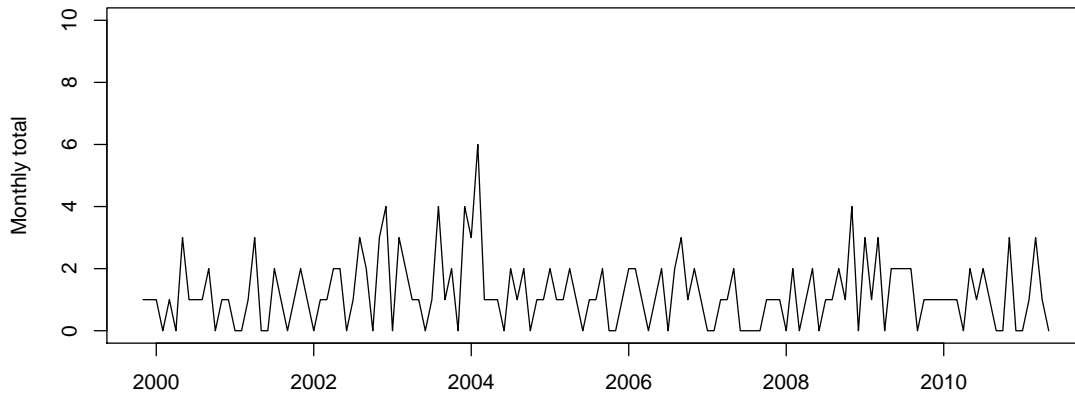
**Fig. 4.** Monthly Admissions to Emergency; decomposition of data into trend, seasonal, remainder

a moving window of length 21 months, draws us a slowly evolving seasonal effect, a fairly smooth trend, and what is left over. This is pure data-analysis, no explicit modelling assumptions are being made, we are just applying a standard time-series algorithm called STL (LoESS) to let the data speak for itself, using the algorithm's default "parameters" for monthly time-series data. STL stands for "Seasonal and Trend decomposition using LoESS (locally estimated scatterplot smoothing)". What do we see? Up to summer 2004 it is getting continuously busier and busier. The number of patients being treated in Emergency almost doubles from about 400 per month to about 800 per month. One may wonder if the number of nurses in ED also doubled during this period – it's highly doubtful. The "too small" HGH was struggling to fight off closure threats, staff was working harder and harder to keep it open. Then, the number collapses. Possibly due to the situation which arose after Ben's arrest and trial, potential patients tended to go elsewhere, if they had the choice; but more likely, the policy of local health authorities was dramatically changed, too. Why? Nobody has ever told us. 25 miles away is the very big teaching hospital Oxford Radcliffe, and in fact Banbury's Horton General is part of the Radcliffe NHS trust group of hospitals (nowadays called the Oxford University Hospitals NHS Foundation Trust). For whatever reason, the number subsides to 500 – 600 per month. As mentioned before, there is a sudden dip in the very last month, but that is meaningless: the last month was not quite over when the data was submitted. The analysis should be redone without that observation (but when we do that, nothing substantial changes).

The seasonal effect shows a strong annual spike downwards. It's the Januaries! It is well known that in the Northern hemisphere, everywhere where there really is a "winter", people simply stay home, and in particular, don't go to hospital if they can help it, in January. There are, for instance, much less car accidents than in any other month, because much fewer people are out on the roads. Old people avoid slippery paths by staying at home. Apart from that we don't see any patterns. Accidents happen, and medical emergencies happen, at pretty constant rate during the year. Correcting months for their varying numbers of days (remember February) makes no discernible difference.

What is absolutely clear is that the number of people coming to that hospital was steadily increasing in the years before Ben's troubles. What about the numbers of nurses, of beds, of consultants? We plainly see the amplitude of the monthly deviations from what you would expect based on smooth annual trend and smooth seasonal average, increasing with the overall scale. The bigger the overall expected number, the bigger the random variation. This means in particular that at the time which interests us most (winter 2003 – 2004) the random variation is largest!

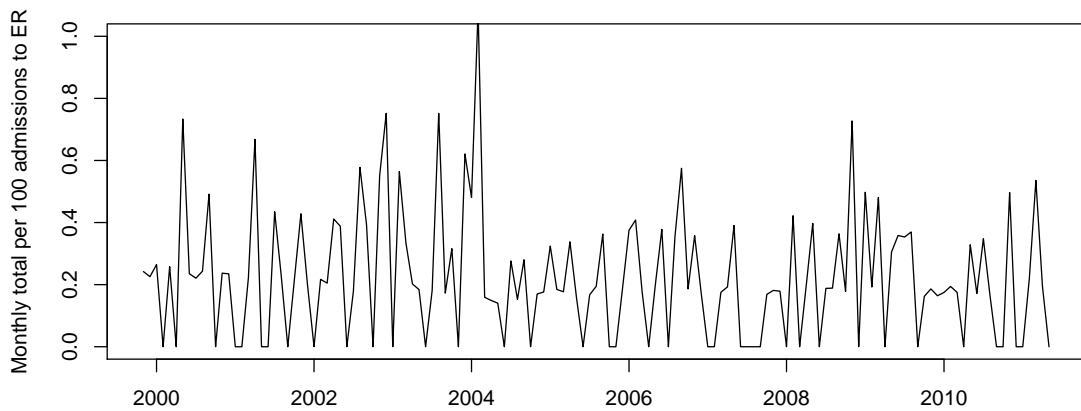
Let's look (Figure 5) at the total numbers of transfers to Critical Care (i.e., the patient is no longer waiting in the corridors for someone to make a decision, but is actually put in a hospital bed in an intensive care ward) from Emergency. We have the numbers with the interesting diagnoses of cardio-respiratory, respiratory, and hypoglycaemic arrest, but we don't know if the "arrest" had been diagnosed before the patient was brought to the hospital, or if it only occurred while the patient was waiting at Emergency. Very sick patients who have to wait a long time in Emergency before anyone can do anything with them are likely to suddenly get a lot worse while they are waiting. What do we see? Just what we would expect, given the total numbers of admissions which we just



**Fig. 5.** Admissions from ED to CC with CR, Resp or Hypo arrest

studied. A slow increase, then a collapse to a stable, lower number. Take a look at what happens (Figure 6) if we normalise the numbers by looking at monthly totals per 100 admissions to ED. It looks as though nothing is going on here at all. December 2003 and January 2004 are low but February 2004 is high. There is a spike upwards in February 2004 (when Ben is mostly absent), and another spike upwards in November 2008. Both of those spikes coincide with local peak levels of the monthly numbers of admissions to Emergency. *Remember that Ben Geen did not work at the hospital after 5 February, 2004.* More than half of the big peak in February 2004 has absolutely nothing to do with him. January 2004 is strikingly high but not more so than was February 2004. The only thing that is unusual in those months December 2003 – February 2004 is that events are being classified as *respiratory* arrest instead of as *cardio-respiratory* or *hypoglycaemic*. Why does the number of cardio-respiratory arrests fall so suddenly in those three months? Do we really believe that there were *no* cardio-respiratory arrests in December 2004? When were those numbers “fixed” in the official records: day by day as patients were admitted? Or retrospectively after Ben’s case started, 5 February 2004?

The prosecution case would be that the respiratory arrests were “extra” events which occurred in ED through Ben’s deliberate actions; the patients in question perhaps came to ED because of an earlier cardio-respiratory arrest. Against this is the fact that no-one ever saw Ben doing anything at all which he shouldn’t have been doing. One has to go into the medical evidence. There are original hospital records which are sketchy and/or a total mess and impossible for a layperson to interpret. The medical experts for the prosecution are in no agreement at all as to what caused what collapse, except that they are willing to see something strange about each one, and willing to argue that Ben *could* have been to blame. The defence experts have sound reasons to reject many



**Fig. 6.** Admissions from ED to CC with CR, Resp or Hypo arrest per 100 admissions to ED

of the hypothetical stories of the prosecution. The extensive dossiers concerning the 18 selected patients were debated at length during the trial. The jury decided that Ben had deliberately harmed 17 patients, and in two cases, that this led to their early deaths (earlier than would have been expected). So 17 families received large compensations, no doubt ultimately paid for by the tax-payer. Ben is in jail, still. Somehow, he does not have the media appeal which some other victims of miscarriage of justice do have. That damned syringe grabs the imagination.

One thing is clear, the barchart of Figure 2 is utterly misleading. Yet it was a standard part of the documents handed out to every medical expert. A nice example of how to lie with statistics without saying a word.

In our opinion, his legal team has made some errors of judgement, but they too are feeling their way in the dark. The English system means that you are initially helped by your solicitor; a family lawyer who may have very little experience in serious criminal cases. The solicitor needs to recruit a barrister (and preferably a QC, Queen’s Counsel). At a very late stage Ben’s QC had to be withdrawn from the case leaving scarce time for a new QC to get fully up to speed. Very good barristers are very expensive and don’t actually have a lot of time, leaving a lot of work to paralegal assistants. In this case, the case was used as a start-up in a “freedom project”. Some law students got things moving. And then over the years, the students evaporated, their initial work going to waste. Without actually consulting with a statistician they decided to gather a lot of statistical data through freedom of information requests to numerous hospitals. A lot of data came in, typically in the form of pdf files of printouts of Excel spreadsheets prepared by reluctant and busy hospital administrators. Often there is no indication what the meaning of a space is, often small numbers were replaced by “less than 5” in order to protect the anonymity of the patients concerned. The actual meaning of the request was

definitely ambiguous. And anyway, these diagnoses are vague and multi-interpretable.

But it must be admitted, the statistician recruited by Ben's legal team just couldn't cope with the mess he had got into. R.D. Gill tried honestly to answer the question which was put to him, see Gill (2014), but in hindsight it was an irrelevant question (as the CCRC was swift to point out). He did what he could in a short time (making many more hours than he had budgeted for), with the help of a succession of two students, both of whom got severely depressed by the work and moved on to something else, though fortunately not before making magnificent progress in "unlocking" the data for us. Though British, Gill was also not familiar at all with the English legal system. He went public with his findings and his further opinions about the case, which definitely is "not done". It gave the lawyers of the CCRC the perfect excuse to disqualify any contribution by him or by people influenced by him.

And finally, this case, like Lucia's, depends on lawyers and on medics. As long as Ben does not have a prestigious English *medical* expert publicly on his side, there will be little impetus for anything to happen.

How to get that to happen? One solution might be through the intermediary of a famous English statistical expert, one with connections in the corridors of power ... one who rubs shoulders with influential people in the medical establishment. Ben did already gain the support of suitable persons in the British statistical world who wrote some powerful letters to the CCRC, but so far to no effect. The CCRC says that the statistics are a sideline. There is the syringe, and there is the medical evidence. Ben needs the public support of an influential person in the medical establishment.

But maybe the law is enough. Here is the opinion of one English lawyer:

The hospital's illegal and unqualified investigation team was only looking for evidence to secure a conviction (Confirmation Bias) while discarding or ignoring evidence that proved Ben's innocence. The hospital's Serious Untoward Investigation Team initiated by Chief Nurse Brock in her capacity of Executive Lead for Governance consisted of several medical, nursing and medical records staff who were all untrained in forensic investigative techniques, crime scene preservation and the taking of witness statements. The team carried out an unlawful and flawed investigation, the material from which was later presented to medical experts appointed by the prosecution as legitimate. The opinion of these medical experts was based on flawed evidence, which had been given to those experts without their knowledge of how that evidence had been obtained. Expert opinion given on the basis of ignorance of improperly obtained evidence invalidates that medical expert evidence. The judge and jury were not aware at the trial that the evidence had been unlawfully obtained, nor of the risks to justice associated with it.

Alongside of the general concept of confirmation bias we would like to mention the *Baader-Meinhof Syndrome*, here in reverse time: the retrospective reclassification of incidents.

We have absolutely no doubt that the team and everyone else concerned was acting with the best of possible intentions. We think that Ben Geen deserves a fair re-trial, and the statistical community (but also the medical, legal, and media communities) need to learn from these experiences.

## 6. Postscript

It doesn't end here; cases like this just keep on happening, all over the world. If any Italian statistician is interested in working on a similar Italian case, we have a lot of very interesting and challenging data on the case of Daniela Poggiali, which we'd like to share with them, and many ideas about what might be going on there.

### **Appendix 1: epidemiology and unexpected clusters of events**

### **Appendix 2: the view from forensic psychology and criminology**

### **Appendix 3: Bayesian approaches**

#### **References**

- Elffers, H. (2002a) *Distribution of incidents of resuscitation and death in the Juliana Kinderziekenhuis and the Rode Kruisziekenhuis* (Unofficial English translation of Dutch original). <https://www.math.leidenuniv.nl/~gill/Elffers1eng.pdf>
- Elffers, H. (2002b) *Elaborated analysis. Distribution of incidents of resuscitation and death at the Juliana Kinderziekenhuis and the Rode Kruisziekenhuis* (Unofficial English translation of Dutch original). <https://www.math.leidenuniv.nl/~gill/Elffers2eng.pdf>
- Gill, R.D. (2014) Rarity of respiratory arrest in ED? *arXiv:1407.2731*. <https://arxiv.org/abs/1407.2731>
- Gill, R.D., Groeneboom, P., and de Jong, P. (2018) Elementary Statistics on Trial (the case of Lucia de Berk). *Chance* **31** (4), pp. 9–15. <https://doi.org/10.1080/09332480.2018.1549809>