

# Lessons from Lucia

Statistics in the case of Lucia de Berk

JKZ MCU-I  
Oct '00 – Sept '01

		<u>incident</u>	
		with	without
<u>Lucia</u>	with	9	b133
	without	0	b887

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RKZ-42  
Aug – Nov '97

<u>Lucia</u>	with	b6	b52
	without	b9	272

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RKZ-41  
Aug – Nov '97

<u>Lucia</u>	with	1	bb0
	without	4	361

Shifts in 3 hospital wards

# A little background



<Tarantino clip>



# A little background on Dutch Criminal Law

- Inquisitorial, not Accusatorial
- No jury: professional judges
- Central Position of Public Prosecution
- Paper, not people
- Swift, efficient justice
- Lower court, Appeal court, Supreme court
- Some spectacular miscarriages of justice

Shifts	with incident	without incident	Total
with Lucia	9	133	142
without L.	0	887	887
Total	9	1020	1029

- The case of Lucia de Berk
  - Lucia's vital statistics
- Lessons for forensic statistics, ...
  - Tamara Wolvers
- Why did it happen? Unique?
  - Kevin Sweeney, José Booij, ...

# Dramatis Personae



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17 judges: Fokkens, Fokkema, Fokking...

JKZ director Smits

The Derksen family

An army of medical experts

...



# Dra... B... nae

17 judges: Fokker  
JKZ director Smit  
The Derksen family  
An army of medic  
...





# Dr. ... ae

17 judges: Fokker  
JKZ director Smit  
The Derksen family  
An army of medic  
...



# 2001: JKZ, the Hague

- 4 Sept, early morning: baby Amber unexpectedly (?) dies; natural death registered
- Same morning: a nurse goes to head nurse goes to *chef de clinique* with “bad feeling”: *Lucia was on duty again ...*
- C-C does Excel spreadsheet statistics: no coincidence... goes to director Smits
- 4 Sept: Amber’s death is now unnatural; together with 4 others, reported to authorities
- 6 Sept: press conference (TV, newspapers)
- By 17 Sept: 29 incidents & deaths at JKZ and RKZ attributed to Lucia; gossip; ...

# 2003: the Hague Lower court



- Lucia pleads innocent
- and gets life sentence for 4 murders + 2 attempts at JKZ, RKZ, Leienburg
- Statistics essential: “1 in 342 million”
- No medical proof. Only statement of co-detainee
- Both defence and prosecution appeal

Elffers: “Your honour, it was not chance. The rest is up to you.”

# 2004: the Hague Upper court

- Lucia gets life sentence + TBR for 7 murders + 3 attempts
- Medical proof that Amber died of digoxine; it was administered by Lucia (opportunity); motive: compulsion
- No statistics
- Chain argument
- Defence appeals (*novum* – mislaid Strasbourg lab finding “no digoxine”)

TBR = *ter beschikking rechter* = permanent detention in psychiatric care

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- <sup>???</sup>No statistics
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TBR = *ter beschikking rechter* = permanent detention in psychiatric care

# 2006: the Hague Supreme court

- Conviction is upheld except that TBR is ruled illegal (\*)
- Upper court (a new one) complies
- Lucia suffers a stroke

(\*) No relevant psychiatric disorder + non-guilty plea

# Meanwhile ...

- Medical doctor Metta de Noo (*née* Derksen), sister-in-law of JKZ chief paediatrician Arda Derksen (*née* Lubsen) becomes uneasy
- The Derksen family is split; “committee Lucia de B.” researches case
- Philosopher Ton Derksen publishes *Lucia de B: reconstruction of a miscarriage of justice*  
growing media interest
- Computer scientist/statistician Peter Grunwald reads it and makes me read it too  
growing media interest
- 2006: Derksen submits to CEAS:  
Committee for Evaluation of Closed Cases



2007

# Report of the CEAS

- Prosecution of case was tainted by tunnel-vision from very beginning
- “Experts” were chosen from small circle around JKZ, later advised police, later advised courts
- Experts disagree on cause of death of Amber
- Case should be reopened



17 judges can't all  
be wrong!

They don't  
have the full  
dossier!

# The public debate

- Slowly, the media change sides *NATURE!*
- Petition for reopening the case to minister; candle-light demonstration at prison; newspaper full page advert; ...
- The legal establishment digs in its heels *Nobel laureate!*
- Politicians are silent *Undermining the foundations of the state!*
- The medical establishment is silent
- Intellectuals, artists, scientists become involved
- Public opinion and academic opinion are won for Lucia
- Key figures in legal establishment are won for Lucia

# 2008 The supreme court

- Advocate-General sees no *novum* in CEAS report
- Despite this, he commissions a multi-disciplinary medical investigation into case of Amber
- Lucia's sentence is temporarily suspended
- Investigation findings: Amber's death could easily have been natural (exhaustion)
- A-G notes that Lucia did not lie about her doings and asks key trial expert if he agrees with new findings – Yes; he had been given incomplete information!  
A-G requests Supreme Court to reopen the case
- Supreme Court complies

# 2009: the last act

- Prosecution proposes major new *forensic-criminalistic* investigation (vs. defence's *theoretical-scientific*), on lines of “tender” by Independent Forensic Services
- ... but the court continues A-G's medical investigation into cases of Amber, Achraf, Achmad only



- *Still never been heard:*
  - a professional statistician
  - from medicine: the 2 qualified persons with overview of whole case (Arda Derksen, Metta de Noo)



# 2010: the verdict

- Lucia is innocent
- All the deaths were “natural”
- Nurses’ professional conduct was exemplary
- Usual medical errors in diagnosis, treatment, ...
- Minister of Justice and Chief Public Prosecutor and Head of Judiciary apologize



- *Still never been heard:*
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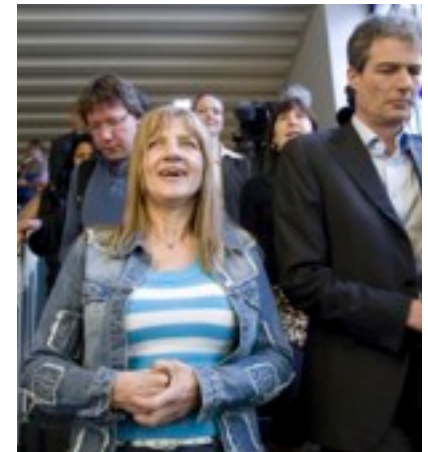


# 2010: the verdict

- Former director of JKZ: would do the same again today
- Chef-de-clinique at JKZ: would do the same again today
- Board of hospital: “we are a great hospital, and we always cooperated fully with justice department”
- 30% of Dutch population believes “she did it”



- *Still never been heard:*
  - a professional statistician
  - from medicine: the 2 qualified persons with overview of whole case (Arda Derksen, Metta de Noo)



# Where was statistics?

- Statistics initiated the case
- Statistics central to 2003 conviction
- 2004: “*no statistical probability calculation*”;  
“*all deaths and incidents shown by incontrovertible medical-scientific evidence to be unnatural*”
- ... yet from publication of Derksen’s book, statisticians at the heart of public movement to reopen case: why?

# The Statistics

## Lucia's working places

- Juliana Kinderziekenhuis (JKZ), *mcu*
- Rode Kruis Ziekenhuis (RKZ), *icu-42*
- Leijenburg Ziekenhuis
- Penitentiaire inrichting, Scheveningen



# The Statisticians



For the police, and later for the lower and higher court:

- Henk Elffers (*law psychologist*)
- Richard de Mulder (*law and ict*)

For the defence (on appeal)

- Ronald Meester (*probability theory*)
- Michiel van Lambalgen (*AI, logic*)





## Shifts

## Court data

JKZ MCU-I

incident

Oct '00 – Sept '01

with without

<u>Lucia</u>	with	9	b133
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# Elffers' 1 in 342 million

- Three Fisher exact tests
- JKZ: *post-hoc* correction by Bonferroni: 26 nurses
- Multiplication of three *p*-values
- Elffers emphasized that correlation  $\neq$  causation
- *By way of example, perhaps:*
  - Lucia is a bad nurse (but not a murderer)
  - Lucia has more difficult shifts
  - Lucia has more night shifts
  - Someone is trying to set Lucia up

# de Mulder confirms

- Elffer's methodology is correct
- Even if the data is not completely correct, conclusions won't be changed
- It is certainly not a coincidence
- Lucia must explain why she was there

# Statistics out, from 2004?

- The incidents at JKZ occurred in a short period in a ward where usually nothing happened
- Lucia was present every time
- A natural cause was ruled out, medically, in every case
- Lucia couldn't explain why she was repeatedly present

# Statistics out, from 2004?

- The incidents at JKZ occurred in a short period in a ward where usually nothing happened ?
- Lucia was present every time ?
- A natural cause was ruled out, medically, in every case ?
- Lucia couldn't explain why she was repeatedly present ?

# The legal concept of irrefutable medical-scientific proof of unnatural death

- If the precise time of a death from complex causes can't be predicted, the (time of) death is *inexplicable*
- An *inexplicable* death is a *suspicious* death if Lucia is present, and hence perhaps *unnatural*
- For every case separately, a majority of medical experts thought the death was natural; but always one could be found who thought it unnatural
- In two cases, only one expert thought it was unusual; why? *Only* because Lucia was there!

# Elffers and de Mulder's expertise come in handy

- Chain proof: we have a lying murderess who was present at similar medically inexplicable events
- She must explain her presence (de Mulder), escape clauses (Elffers) are ruled out by herself

Judge: “*Mrs de Berk: were you a bad nurse?*”

Lucia: “No, your honour, my superiors and colleagues ...”

Judge: “*Mrs de Berk: did you work more difficult shifts than your colleagues?*”

Lucia: “No your honour, we shared all the work fairly ...”

# More sharp legal thinking

A-G anticipates supreme court  
counter-arguments

- That Amber died of exhaustion on Sept 4 doesn't mean that she wouldn't otherwise later have died of digoxine poisoning
- That there were similar clusters of events at JKZ in earlier and later years doesn't mean that every one of the deaths in "Lucia's cluster" are natural



## Shifts

## Court data

## Corrected data

JKZ MCU-I

incident

incident

Oct '00 – Sept '01

with without

with without

Lucia

with  
without

9 b133  
0 b887

b7 b135  
b4 b883

RKZ-42

Aug – Nov '97

Lucia

with  
without

b6 b52  
b9 272

b5 b53  
10 271

RKZ-41

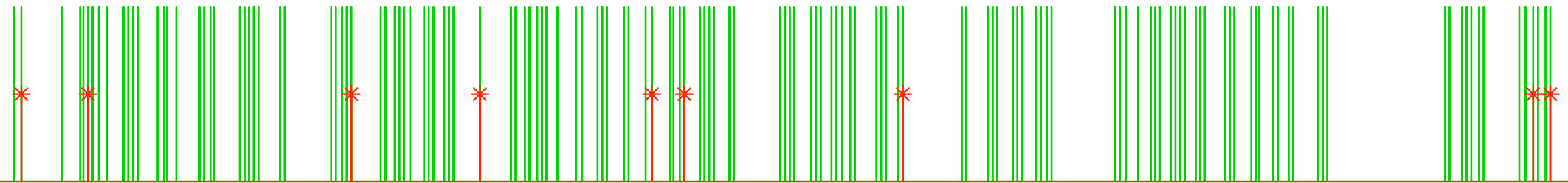
Aug – Nov '97

Lucia

with  
without

1 bb0  
4 361

1 bb2  
4 359



- Three children represent  $7=2+2+3$  of the now 11 incidents (one illegal euthanasia removed)
- Two incidents actually occurred in the shift *after* Lucia's
- At least two incidents outside of Lucia's shifts are missing (they weren't *suspicious* incidents)

# Some $p$ -values (new data)

- Cochran-Mantel-Haenszel test  
JKZ; RKZ-41, -42; & Elffers' post-hoc correction  
*1 in 916*
- Ultimate stratification  
11 *days* at JKZ with both incident & Lucia on duty  
*1 in 25*
- Gamma(1) heterogeneity over Poisson intensity  
JKZ, RKZ pooled  
*1 in 25*

# & what about ... ?

- *Post-hoc* problem
- Data selection problem
- Information from outside Lucia period;  
total number(s) of incidents.  
[Elffers analyses distribution of incidents *between* nurses,  
*within* period]

# Statistics in Court: 3 Approaches

- Classical significance testing  
null hypothesis; alternative hypothesis; p-value
- Bayesian synthesis  
posterior odds = prior odds  $\times$  likelihood ratio
- Likelihood Ratio

# Likelihood Ratio

- What is hypothesis of defence,  $H_D$ ?
- What is hypothesis of prosecution,  $H_P$ ?
  - Elffer's  $H_D$ : conditional on shifts, incidents are uniformly random
  - Defence: you can't use statistics  
 $H_D$ : the incidents would have happened anyway
  - Prosecution: the incidents happened because Lucia proved them, so they were certain  
 $H_P$ : the incidents happened because Lucia was there

# Basic empirical research for $H_D$ still missing

(let alone  $H_P$ )

- Events are strongly clustered
- Shifts fall in regular patterns
- Variation between nurses  
[a nurses' actions can *define* when/what is an incident]
- Differently qualified nurses do get different shifts
- A hospital ward is in a non-constant environment  
[winter/summer, changing admissions/discharge policy, opening/closing other wards]
- Multiple incidents concerning same patient

- Hidden confounders cause heterogeneity between nurses, between days
- $\text{var}(X) = E(\text{var}(X|Y)) + \text{var}(E(X|Y))$
- *Independent uniform* random rare events (Elffers):  
variance  $\approx$  mean
- Unmeasured heterogeneity:  
variance  $\gg$  mean

The basic empirical research for  $H_D$  is still missing ...

and as long as it remains so, statistics does not help the prosecution (though it might help the defence!)



# Likelihood Ratio problems

- parties must *agree* on “sampling frame”
- who owns the hypotheses?
- posthoc hypotheses not allowed
- **nuisance parameters**
- ...
- The defence isn't obliged to play the game (the *prosecution* must convince the *court* that, beyond reasonable doubt, ...)

# Lessons from Lucia: science and law

- Many reforms are being made
- “Science” and “Justice” are talking together; the judiciary, media are critical
- Still: gut reaction of “system” is:  
*create rules, checklists, registers*
- We want honest cops, upright magistrates, intelligent knowledgable lawyers, wise judges who weigh evidence, use common sense, intellect and humanity
- We want the system to admit mistakes so it can learn

# Lessons from Lucia: the medical world

- Raise status of nursing staff in hospitals, status of nursing
- Scientific diagnostic reporting (“differential diagnostics”) in legal context
- Written scientific expert evidence must be put into public domain (a.f.a.p.), so scientific methodology can be openly discussed in scientific community
- External and independent and confidential medical investigations in Lucia scenarios, before police investigation
- In Lucia scenario’s, statistician must always question the data and go back to the sources
- Multidisciplinary and in particular statistical and epidemiological analysis should be made of data on medical incidents at JKZ, say 1995–2005

# What really happened?

- An independent investigation of the origins and early stages of the Lucia case, “in order to learn for the future” (IGZ?)

- S.E. Fienberg & D.H. Kaye (1991), Legal and statistical aspects of some mysterious clusters. *J. R. Stat. Soc. (A)* **154**, 61–74 (part 1)
- B.C. Yorker et al. (2006), Serial Murder by Healthcare Professionals. *J. Forensic Sci.* **51**, 1362–1371
- K. Ramsland (2008), *Inside the Minds of Healthcare Serial Killers*, Times-Warner ...
- R.D. Gill et al. (bis), to appear ...

<Lucia clip>

- Lies, damned lies and legal truths  
<http://www.math.leidenuniv.nl/~gill/Aernout.pdf>
- <http://www.math.leidenuniv.nl/~gill/#haga>
- Lucia interviewed (in English) on CNBC  
<http://www.math.leidenuniv.nl/~gill/Lucia.mp3>

<http://www.math.leidenuniv.nl/~gill>

[gill@math.leidenuniv.nl](mailto:gill@math.leidenuniv.nl)

# Postscript: forensic statistics

- Murder Tamara Wolvers, Alphen aan de Rijn
- Mixed DNA profiles
- “Likelihood Ratio” approach