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**The Sheku Bayoh Public Inquiry**

**Witness Statement**

**Professor Colin Smith**

**Taken by** [redacted]

**on Friday 3 March 2023**

## Witness details

1. My name is Colin Smith. My contact details are known to the inquiry.

2. I am a Professor of neuropathology and a consultant neuropathologist.

## Professional Background and Qualifications

3. My qualifications are BSc (Bachelor of Science), MBChB (Bachelor of Medicine; Bachelor of Surgery); FRCPath (Fellow of the Royal College of Pathologists); and MD (Doctorate in Medicine).

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4. I have been asked to summarise my experience. I've been a consultant neuropathologist for 23 years. I've been professor of neuropathology in Edinburgh for about 10 years. I undertake all of the forensic neuropathology for Scotland.

5. I have been asked in layman's terms if I could summarise what neuropathology is. Neuropathology has two major components: one is surgical neuropathology, which is where the neurosurgeon removes brain tissue from living patients, and we diagnose the condition, usually a brain tumour of some sort; the other is post-mortem neuropathology, where we examine the nervous system post-mortem. So, that is the brain, spinal cord, nerves, sometimes muscles in someone who has died, hopefully to try and have an understanding of any neurological diseases that that individual may have had during their lifetime.

**Neuropathology report**

6. I have been referred to my neuropathology report which is appended to the final post mortem report (PIRC-01445) at page 21. In short, my report confirms that there is no injury to Mr Bayoh's brain or disease of the brain; nothing which accounts for death. The changes that I saw in the brain were secondary to cardiac arrest followed by resuscitation and a short survival period.

7. I have been asked about the changes that I saw in the brain "which appear secondary to cardiac arrest with resuscitation and short survival period", when these changes would start. Nerve cells are very sensitive to a lack of blood flow, as happens after a cardiac arrest. Some are more sensitive to this lack of blood flow and within minutes they become irreversibly damaged. Within about 20-30 minutes, if there has been no successful blood flow to the brain, most nerve cells will become damaged, a condition called global hypoxic ischaemic brain injury.

8. I have been asked what CNS stands for. CNS stands for central nervous system.

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**Excited Delirium**

9. I have been asked if I am familiar with the term "excited delirium." Yes I am. I am aware that the Royal College of Pathologists have issued guidance that excited delirium should never be used as a sole cause of death. I have been advised that the Royal College of Psychiatrists have banned the use of the term and the American Medical Association's view is that current evidence does not support excited delirium as an official diagnosis.

10. I have been referred to Dr Steven Karch's report (PIRC-02526(a)), at page 3, where he lists the generally recognised components of excited or agitated delirium, and there is then a list of symptoms from A to K within. He then says:

> *"The results of thorough in-vitro studies of human brains harvested from those who succumb suggest that most, probably all, of the symptoms listed are as a consequence of dopamine excess. As is apparent from a review of the list, dopamine excess could account for most of the behaviour observed in Mr Bayoh."*

**Dopamine excess in the brain**

11. In support of his suggestion that dopamine excess causes the symptoms of excited delirium in this report, Dr Karch cites the research of Professor Deborah Mash of the University of Miami.

12. I have then been referred to a more recent example of research on this subject by Professor Mash[1] which reports: *"The neurochemical pathology examination of brain tissues after death revealed a loss of dopamine transporter regulation together with increases in heat shock protein 70 (hsp70) expression as a biomarker of hyperthermia. The similarity in the behavioral symptoms between extremely agitated psychostimulant abusers and unmedicated psychiatric patients suggests that a genetic disorder that*

[1] Mash DC. Excited Delirium and Sudden Death: A Syndromal Disorder at the Extreme End of the Neuropsychiatric Continuum. Fro[redacted] Oct 13:7:435

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*leads to dysregulated central dopamine transporter function could be a precipitating cause of the acute delirium and sudden death."*

13. The article makes the following conclusions *"Elevated synaptic dopamine when coupled with failed dopamine transporter function leads to agitation, paranoia and violent behaviors associated with ExDS [Excited Delirium Syndrome]."* And further that *"Excited delirium is a syndromal disorder, which is controversial and highly debated precisely because the mechanism of lethality is unknown. However, molecular studies of the brain of autopsy victims who died in states of excited delirium reveal a loss of dopamine transporter function as a possible trigger of a lethal cascade of neural activities that progress to asphyxia and sudden cardiac arrest."*

14. I have been asked whether I am aware of the research of Professor Mash in relation to dopamine testing on brain tissue and excited delirium, and whether this is considered to be robust, peer reviewed research.

15. I don't know her research. I am aware of a detailed systematic review of excited delirium which was carried out by a Dr Gonin (WIT-00034) found that the evidence levels associated with the diagnosis of excited delirium, including the work of Dr Mash, was either low or very low. That is, there is no real basis on which to make a diagnosis of excited delirium either clinically or pathologically.

16. I would need to examine Professor Mash's research in relation to brain tissues and excited delirium. However, in order for this to be robust research, it would need to look at large numbers of people to look at normal sudden death without drug use or a suggested excited delirium. You would need to look at age-matched controls, so people this sort of age, what are their levels; Males, females, people with alcohol excess, no alcohol etc. There are so many variables to assess before drawing a definitive conclusion.

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17. Looking at the article I have been provided by Professor Mash, I think this is probably not the highest standard of research that that we're dealing with. There doesn't seem to be a lot of evidence presented in this review paper. A lot of it comes from other drug misuse cases, cocaine abuse. A lot of the literature is quite old, to the 1980s, 1990s, so it rather suggests to me that this is not terribly robust.

18. In the article, it speaks of post-mortem neurochemical studies from the 1990s. For this, what you need to do is mash up bits of fresh brain tissue and look for these very specific proteins. However, in relation to Mr Bayoh's case the trouble is the brain tissue we have is not fresh but is all in little paraffin blocks. I think the chances of getting good quality biological data from that tissue is extremely remote.

19. I have been asked if there is anything in the Professor Mash's research that suggests that the changes in the brain, which are claimed to be caused by excited delirium, can be seen under a microscope. No, there nothing I can see that suggests her research is suggesting structural change. There is nothing in her literature that suggests there is anything a pathologist would see in the brain. So, what you would have to do is mash up fresh brain tissue, and look for very, very specific proteins which you would do that at a biochemical lab. So, nothing that the pathologists would ever get involved with.

20. I have been asked that when a pathologist examines a brain whether it is possible to see dopamine excess. Absolutely not. Unless you mash up fresh brain tissue and specifically measure the level of dopamine in that mashed up tissue, you cannot detect it. You would need to know exactly which bit of the brain to do that in because dopamine is quite localised about where you find it in the brain. Essentially, a pathologist would never diagnose dopamine excess looking at a brain.

21. My big issue with the research is in terms of what are you comparing it to? So, what are these proteins in normal people or people who don't take cocaine or people who did take cocaine and years later die of something else? There are a wh[redacted]riables here. How does it change with

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age, etc.? So, it strikes me, the fact no one else has picked up on this, that it's just not very good science.

22. The response of the Royal College of Pathologists, Royal College of Psychiatrists and the American Medical association appear to answer the question "Is this good science?" The answer is "no" because, if there was a level of scientific evidence that says "Yes, this is a clear and consistent change in the brain with a clear and obvious clinical pattern" they would accept that as being true disorder with a biological cause. If you have this change in dopamine or dopamine transporter proteins, this is the clinical picture you see all the time in excited delirium, and nothing else will cause it or at least very few other things will cause it. If that were true, the Royal College of Pathologists, Royal College of Psychiatrists, American Medical Association would all be saying, "Okay, that's fine." So, it suggests to me there remains a lot of uncertainty around this.

23. The Royal Colleges look for levels of evidence, and it clearly does not exist in this space for excited delirium. Delirium is well-recognised; clinicians have no issue with that. Again, in an individual who dies of delirium, we don't see anything in the brain. So, proper clinical delirium at post-mortem, the brain looks entirely normal because it's an imbalance of chemicals – we think. The actual evidence base for delirium, what causes it, is not 100 per cent understood. Edinburgh is actually a centre of excellence for research in delirium on the clinical side. So, excited delirium, I cannot imagine the evidence base is any better. From a clinical perspective, it sounds to me as if there's zero evidence base for it, or else the psychiatrist would use it, pathologists would use it; "Here's a set of symptoms. We've done a blood test. They tick all the boxes for excited delirium." The fact that none of that exists sort of speaks volumes to me that this is not a robust diagnosis.

24. I have been asked if from a neuropathology perspective if I am aware of evidence which demonstrates or supports the use of "excited delirium" in medicine. No, a neuropathologist would never use that term in the same way I would never diagnose delirium when I examine a brain because there's

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nothing to see. I would never make a diagnosis of excited delirium because there is nothing to base it on. If I look at a brain, I know how to make a diagnosis of Alzheimer's disease because there are cellular changes. I know how to make a diagnosis of Parkinson's disease, and that's an abnormality of dopamine but it leaves structural changes behind. Delirium and certainly excited delirium don't leave any cellular changes behind; there's nothing that I can see looking down a microscope.

25. I'd be very confident of that with regard to whatever delirium it is, it does not leave any structural changes that a pathologist could identify.

26. We've got a case here of an individual who had this for a number of hours and then went into cardiac arrest, was resuscitated for an hour or so, and died. So, to get all these protein changes happening in that space of time is not impossible, but to suggest that there is a consistent fingerprint, let's say, at a neurochemical level that can only be excited delirium seems a bit of a stretch to me. I think, if the evidence was that clearcut, we would use it in this country so that suggests to me there's a problem.

27. Even if you were to consider that these protein changes could have taken place in an individual like Mr Bayoh, what Professor Mash is talking about is at a chemical level, not in a structural level. So, they're talking about measuring different proteins in the brain by specialised biochemical methods, which I don't know anyone in Scotland or the UK who would do that.

**Instruction to examine the brain**

28. I have been asked when I am instructed following a post mortem to examine a brain and a spine, how does that normally come to me. The lead forensic pathologist would usually email me to say that they'd just finished the post-mortem examination and they had retained the brain for specialist examination. I will then arrange to undertake that examination. I usually try and do this as quickly as possible because I know it becomes a delay for

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release of the body if families are wanting to undertake funeral arrangements. Therefore, I usually always try to do this as quickly as possible.

29. I have been asked if I have any recollection of how the arrangements were made in relation to Mr Bayoh. I can't remember the specifics of this case.

30. I have been referred to an internal email ([redacted]) authored by David Green who was head of the Scottish Fatalities Investigations Unit providing an explanation as to how the examination of the brain and spine came about. It states *"This is to confirm Colin Smith went to the neuropath laboratory at the NHS Lothian in the early hours of this morning in order to carry out the neuropath examination of the brain of Mr Bayoh. I understand the reason for this was that he was leaving Scotland to attend a meeting and was not due back for a number of days. I have no doubt that Colin did this in an effort to ensure there was not a delay in reuniting the brain with the body and that delays were minimised."*

31. Yes, I think perhaps I was going off to a meeting somewhere for a few days, so I wanted to do that before I went to the meeting, so I would make sure it was dealt with. I don't like to have these cases waiting such that potential release of the body is being delayed because I have not examined the brain yet. You may be aware that pathology departments all across Scotland had rooms full of brains sitting in buckets of formalin because we used to just retain the brain indefinitely; it didn't go back to the body. I was very much involved with the processes that changed that.

32. I think it's much better that the brain is returned to the body, and then the funeral can go ahead. So, therefore, to facilitate this, I always try to examine the brain as quickly as is reasonably possible for me, and that's true whether the brain is in Edinburgh, Glasgow, Aberdeen, Inverness, wherever. So, to examine the brain, you know, within 48 hours of the post-mortem is not unusual, especially in Edinburgh where I can manage it much more quickly. So, I usually always try to do this within a day or two of the post-mortem.

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33. I have been asked if I specifically remember in relation to this case how I was contacted? I'm pretty sure it will have been the email. Kerryanne usually just drops me an email to let me know there's a brain ready to be examined.

34. I have been asked if I remember anyone contacted me after the initial instruction to ask me not to proceed or to put it on hold. No. I had no idea Crown Office wanted the examination put on hold, so that's the first I've heard of it. No-one has ever contacted me about that.

35. I have been asked if a neuropathologist is always instructed to look at the brain and spine for those cases or is it just particular cases that are chosen. It's just particular cases. So, essentially, the Procurator Fiscal Instructs a forensic pathologist to undertake the post-mortem examination; it is their case. Now, it may well be a two-doctor case, in which case another forensic pathologist will be involved, and they share responsibility for the case. They are the ones who will decide if there's specialist brain examination needed or specialist heart examination needed, for example. Occasionally they will phone me in advance, say "We've got this case. What do you think?" But they will make the decision at the time of the post-mortem.

36. For many deaths, they will just take a few small samples of brain which they can report themselves or they can let me have a look at if it's difficult, but occasionally they will retain the whole brain. So, if it's a homicide with clear head injury, they'll usually always retain a whole brain. If it's a complex death, so deaths in care homes, sometimes they will retain the whole brain. In custody deaths or restraining deaths like this, they will sometimes retain the whole brain. It's really just to try and exclude, "Has there been a neurological process that has directly or indirectly contributed to the cause of death in these more complex cases?"

37. I have been asked since the cause of Mr Bayoh's death was unascertained at the conclusion of the post-mortem, whether that would that be a classic example of a case in which a neuropathologist would be instructed? It would be. You could have an unascertained death, for example a young person

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found dead with no external marks to them, and they probably wouldn't retain the brain because it is likely to be to be some form of drug-related death or cardiac death; but where there has been a suggestion of a physical intervention, they would almost certainly always retain the brain just in case there's some undiagnosed traumatic brain injury that could have been important in the whole process.

38. I have been asked if where a person has been restrained and has died suddenly, would you expect to see anything in the brain. No, we don't. So, in many ways the brain examination for these cases is just to exclude pathology. We're not doing it because we're expecting to find anything; we're doing it because we want to exclude any possible undiagnosed pathology that might have contributed.

39. I believe the facts stated in this witness statement are true. I understand that this statement may form part of the evidence before the Inquiry and be published on the Inquiry's website.

Date ..... April 19, 2023 | 11:09 AM BST

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