Supplementary Material

Table i. Transcription quotes sorted by theme.

Theme	Code	Respondent	Quote
Validity	Traditional research is embedded in the process of becoming a surgeon	Surgeon 1	[How long have you been involved in traditional research?] 18 years.
		Surgeon 2	We've been bumbling around with this probably since back in the mid-90s, so about 28 years.
		Surgeon 3	And well, throughout the career until you actually get into the elderly part of the career.
		Surgeon 4	I've been involved pretty to some degree… in fact I started medical research in 2000 and I've been pretty actively involved in some form of medical research ever since. So by 20 years, 20 plus years.
		Surgeon 5	Well, for the last 10 or so years since being a trainee, actually leading projects for the last three to four years. It's really opened my eyes as being chief investigator in the last two years or so in a couple of projects.
		Surgeon 6	25 years.
		Surgeon 7	Since two 2003, roughly speaking, probably third year of medical school, second, third year of medical school.
		Surgeon 8	So I did my first paper in 2010. So suppose I have been involved in that kind of research for 12 years.
		Trainee 1	I guess my first research project I did as you know as a medical student was probably XXXX. So I suppose since then, we've kind of been involved in research. [13 years]

		Trainee 2	I'm actually ST three, so right at the start of my registrar training, so I would say probably around two years.
		Trainee 3	Well, I did the academic foundation. I interpolated as well actually, so technically probably about 10 to 11 years cause the university doesn't additional great degree. You were charged dissertation and research component to that as well. So over 10 years.
	Methodology used to validate traditional research	Trainee 1	…if you're looking to have cause and effect then you're not going to be able to answer that, say, with an observation or retrospective study, for instance. So those have been things I would look at. And then I probably would look at in more depth how they analyze the data, what assumptions they made.
		Surgeon 7	So the I guess the methodology of the of the piece of research that you're looking at and if you're appraising that, you know we're sort of classically taught to look at how the research was constructed, how it goes about answering that question. And I guess, I guess we look upon the levels of research particularly clinically. So we have the kind of at the top of the tree with our meta-analysis and then and then randomized control trials, but obviously got a look at the meta-analysis, look at exactly what's gone into it, into the into that analysis in terms of the papers that are being analyzed and then sort of at the bottom of the pile sort of level 5 evidence.
		Surgeon 2	Then I would look at the numbers, you know, what is, you know, what type of work are they doing? Is it a retrospective study which I don't think is wrong to be honest with you, I think can give as good or information sometimes as some of the prospective. Is it a randomized trial? Is it, you know, how did they randomize it? Is it truly randomized? Then look at numbers wise because there are some people doing research and making vast claims on very small numbers.

			Surgeon 6	Well, I'm looking for a difference, but most of the research that we do is based on our controlled trials where we are looking for a clinical or measured difference between one intervention and another. And so I'll be looking for the minimal important clinical difference. Or for a difference in a measurement such as inaccuracy or a or a precision of an intervention.
			Trainee 2	I think I think there's probably two things that are different with good research. I think obviously you've got all the methodological side of it […] And then looking at the sort of method side of what makes that good and the validity, a lot of it is based around statistical analysis, so whether you've got the correct numbers, the correct sample size to begin with and whether you're using the correct statistical tests to actually determine any differences that you might be looking for in a cohort. And what biases are thrown in there, so whether there's bias from it being, retrospective or bias from the people collecting the data.

			Surgeon 8	I look at the methods. So are the methods appropriate to answer the question that they have set? And then other statistics, do the statistics look reasonable to answer the question that that that they have set themselves, are they badly described, which suggests to me that the authors didn't understand what they were doing.
			Surgeon 1	I am quite good at looking at the methodology. Have they got enough patients? Is the bias in the have they looked in a subgroup of patients that aren't really relevant to the average reader.
			Surgeon 4	And I suppose the other thing is robust methodology that answers the question you want to answer. So it's defining a good quality research question and then answering it in the most robust way possible.

	Importance of the question relevant to validity	Trainee 2	But you've also got actually that it needs to be answering an important question that hasn't been looked at before.
		Surgeon 4	I think research that is applicable and meaningful to patients, and generalizable to broad body of patients is important.
		Surgeon 8	So I'm looking. I look at what question are they trying to answer. So have they actually formulated a proper question or is it just a fishing trip?
		Surgeon 6	I'm looking for a difference, but most of the research that we do is based on our controlled trials where we are looking for a clinical or measured difference between one intervention and another. And so I'll be looking for the minimal important clinical difference. Or for a difference in a measurement such as inaccuracy or a or a precision of an intervention.
		Trainee 1	Yeah, I suppose I always look at, you know what I mean? Ultimately, I think research is a question that people have a question they want to answer it. And so they formulate a hypothesis. I always say, you know, look at what is the, what's the aim or what is the question that this study is trying to answer and then how does the study design?
Confusion	Other technologies confused with AI	Trainee 2	My mind instantly jumps to quite wacky ideas, but I know it's not that, but I think that's where my mind immediately goes. But I guess, you know, I think of robotic stuff. I guess, is kind of where my brain goes.
		Surgeon 7	I would say that the Mako Computer falls under the umbrella of artificial intelligence.
		Surgeon 5	Yes, there's more an attempt to replicate kind of human thinking and human decision making by something that's not human. So computers, robots, etcetera.
		Surgeon 5	In terms of the use of artificial intelligence generally, quite specifically in knee surgery, it would fall again under the sort of umbrella of things like computer navigation, PSI robotic surgery and that sort of thing.
		Trainee 3	I mean, I've read a few papers and I went to the BOA the last in time and I went to the computer-based session. I've had demonstrations of ROSA, not Mako. And I have never used one in a clinical setting.

			XXXXXXX are trying to use it as a navigation tool rather than as a robot, really. And their argument is that they will get a lot of data from it to follow patient reported outcomes and know where the implant is to try and find where the best implant position is.
	Attempted definitions	Surgeon 5	There's an attempt to replicate kind of human thinking and human decision making by something that's not human.
		Surgeon 7	My understanding of artificial intelligence is something that is potentially computers or machine generated. And I suppose and in the context of research, that might either be as a research tool, or as a device for analyzing the research.
		Surgeon 1	It models data or it models in user information to basically come up with a prediction model of where a patient will end up, or where whatever will end up being, be it a patient, be it an outcome.
		Surgeon 8	I think my understanding is you take like a a big data set and you come up with some theories based on what that big data set shows use that to validate whatever you're making. So if you're, if you're making something that's gonna look at hip replacement X-rays and it's gonna measure offset for example. Then you do that manually on a load of X-rays, and then you get the computer to do it in its artificial way, and then you compare the two and see if it is reproduced. You know if it is valid, and then nobody needs to look at another X-ray, you can just plug it in through the computer. That's my rudiment understanding of why it might be useful.

		Surgeon 5	And so my understanding is where you give a machine, shall we say in its broader context. So a computer, data around various scenarios and that a computer or machine uses that data to make decisions about in various scenarios.

		Surgeon 2	So it's so for example it is taking significant amounts of data which we would probably struggle with putting those into bite size chunks and be able to look at them in in certainly various ways and produce an answer, and it can find it in a lot quicker way than we probably can.
		Surgeon 4	So I suppose artificial intelligence as I see it is a big pool of multiple techniques. It's not a single thing. And so it encompasses machine learning as well as other techniques. But essentially it's a sort of I see it as a sort of synthetic or computer driven approach to typically data analysis or analysis of something so that you know I say data analysis, but sometimes it's analysis of a shape or some very abstract concept or something. So it's a really I'd say when people say artificial intelligence, my automatic reaction is that's a big broad thing.
Inability to validate	Interpretation not easy	Surgeon 4	The challenge of course with artificial intelligence is it can feel a bit like a black box and you don't quite understand what it's doing. And I think I have a concern about artificial intelligence around it ultimate validity, just because it's observational data and therefore will inherently be prone to underlying biases.
		Trainee 1	I would definitely say I would be more comfortable scrutinizing traditional medical research.
		Surgeon 8	If these papers are going to appear everywhere, which they are, then we need to be able to consume them, and I think at the moment we don't know how to do that because they bandy about terms that we don't understand.
		Trainee 2	I think if I if I had, if there was an artificial intelligence paper that compared against you know an extremely well powered traditional research, extremely good methodologically, like a good methodological randomized control trial, I think I'd want to trust the randomized control trial more.

			Surgeon 1	I think the problem is that I've got with it is. I don't know whether there's a real definition of what it is, so if I was to get a paper across my desk to review I'm not quite sure I would understand all of the methodology.
			Surgeon 5	In the long run down the line, once I've got through that learning process and learning kind of, maybe I'll trust it more, I don't know […]I mean, the reality is I've learned from clinical research, there's so many ways to skin a cat, you know that you want to find any technique you want, you can find something in the literature to justify that technique. And so a lot of it has to be come down to your judgment and trust.
			Surgeon 7	We're relying on that computer program to generate the statistical analysis, we're not doing it, you know, so we don't have any knowledge of the of how that program was generated. So there's a leap of faith.
	Desire to combine with traditional research		Trainee 3	I think that you need to elements of both, so you have the low sample size. RCTs like XXXXX they didn't have a huge sample size and therefore you could argue that it's statistically poor. But then if you combine that with a study with 10,000 people out of registry data you can kind of combine the results to try and find out. I think they both have a place, but you can't expect one to do everything.

			Surgeon 6	We need to start seeing the output of these AI studies before we can fully get behind it. I don't think that doctors in their broadest sense are necessarily suspicious of AI any more than they are suspicious of other technologies, they just need to be to be validated in in in practice.
			Surgeon 4	You know another way would be to consider them different parts of the sort of discovery process. And so I don't particularly see them competing because I don't particularly see it depends what your research question is.

			I think one is gonna be very good for one thing and one is gonna be very good for another.
Cautious optimism	AI seen as reducing of bias	Surgeon 3	The human mind is fairly chaotic and goes by intuition as a very much as opposed to logistical steps. And because it assimilates a huge amount of information and becomes too biased. Whereas the logistical algorithm-based research tries to take step away from those implicit biases that human brains have.
		Trainee 2	Randomized control trials are a risk, you know. Even the ones that have you sort of tightened as much as you can and they are still at risk of biases and that I would assume that the artificial intelligence can almost take that away.
		Surgeon 5	You have subconscious bias when you're running your own trials. You know, we don't want people to do badly. And so I'm sure there definitely is subconscious bias into how we select participants into those trials. [AI] doesn't have bias that I have in terms of looking at patients, assessing patients, it hasn't got that bias. I think, in a way, if you can make the data more pure to take some of that bias out the way the theoretically I could be more likely [to adopt AI research findings]
		Trainee 2	I think a lot of the time with, especially with orthopaedic research, we're often limited with lengths of follow up or number of patients that can be included and exclusion criteria. Which means that even though I would actually like to trust the randomized control trial sort of more clinically applied traditional research methods, often they've got limitations that actually the AI, because it's not limited by those things and it's not limited by patient numbers or biases or loss to follow up, you can end up getting much greater numbers and much more powerful findings.

			Surgeon 4	And so I think as an opportunity to discover new information and gain new insights, artificial intelligence is potentially very powerful because it takes the human eye out of the, you know, the human eye and subjectivity out of the frame and allows you to analyze very large data sets.
		AI able to handle large sample sizes, which is seen as positive	Surgeon 2	Hopefully, with AI, we're dealing with half a million, a million one million, 2,000,000 three million data sets with each one of those data sets having multiple facets of what you're recording.
			Surgeon 4	I would trust artificial intelligence more than I would trust a sort of correlation analysis or an analysis of a case series because I think it would probably account for biases better than that, particularly begin with artificial intelligence is large and you know, very able to handle very large datasets.
			Surgeon 6	AI has the potential for analysing much greater volume of data. So that in itself might improve the quality of the study.
			Trainee 2	I would actually like to trust the sort of randomized control trial sort of more clinically applied traditional research methods, often they are not, they've got limitations that actually the AI because it's not, you know, cause it's not limited by those things and it's not limited by patient numbers or biases or loss to follow up, you can end up getting much greater numbers and much more powerful findings?

			Surgeon 4	And so I think as an opportunity to discover new information and gain new insights, artificial intelligence is potentially very powerful because it takes the human eye out of the, you know, the human eye and and subjectivity out of the frame and allows you to analyze very large data sets.

	General positivity for AI	Surgeon 5	I think really exciting, if a little nervous if I'm honest, you know, because obviously it's taking away what differentiates us traditionally from robots from computers is that human intelligence.
		Surgeon 2	I think it is actually fascinating.
		Surgeon 4	Artificial intelligence is hugely powerful because that's allowing you to explore very complex hypotheses in an objective way. So for me it is a very powerful tool.
		Surgeon 6	There's no doubt that that is the future of research so that we can get so we can get more out of the research that we do and we can learn more about what about what comes after our interventions.