**Centre for Personalised Medicine podcast**

**Season 3 Episode 6**

***Equity***

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(Our podcast logo features a section of the artwork [‘A Lifetime of Measures’ by Aneesa, aged 12, from Oxford High School](https://cpm.ox.ac.uk/centre-for-personalised-medicine-art-competition-2022-23/), the stunning winning entry to our 2022-23 Youth Art Competition).

**SPEAKERS**

Rachel Horton, Anneke Lucassen, Susie Weller, Nishtha Bharti, Maxine Mackintosh

**Rachel Horton**

Hi, I'm Rachel Horton, a Junior Research Fellow at the Centre for Personalised Medicine, or CPM. Welcome to the third series of the CPM podcast where we're exploring themes relating to personalised medicine that we identified when developing our new ten year strategy. In this episode, we’re discussing equity – how personalised medicine approaches can be made equitable across diverse populations. Joining me to discuss it, I’ve got…

**Anneke Lucassen**

Anneke Lucassen, I'm director of the Centre for Personalised Medicine, and I'm Professor of Genomic Medicine at the University of Oxford.

**Maxine Mackintosh**

Maxine Mackintosh, I'm a big fan and fanatic of the use of data and AI to improve health equity, and I do that largely through institutions, so a job job; community organising through two communities that I run, called One Health Tech, and Data Science for Health Equity; and through research, with the new post I have as an affiliate member at the CPM.

**Susie Weller**

I'm Susie Weller, I'm a research fellow in the CPM, and I'm also a senior research fellow in the Clinical Ethics, Law and Society Research Group at Oxford.

**Nishtha Bharti**

Hi, I'm Nishtha Bharti, I'm a postdoctoral research fellow at the Centre for Human Genetics, and a research affiliate at the Centre for Personalised Medicine.

**Rachel Horton**

Thank you so much for joining me today to discuss this really interesting topic. So I guess to kind of kick it off, I wanted to talk to you about what does the equity theme mean to you?

**Susie Weller**

I think it's about how we can make approaches to personalised medicine more equitable for all.

**Nishtha Bharti**

It's also about ensuring that all population groups have fair and equal access to genomic knowledge, services and benefits, regardless of their social or demographic background.

**Rachel Horton**

Historically, there have been loads of challenges in this area with providing equitable personalised medicine. And I know at CPM, we've kind of been involved in exploring these to some degree in the past- I wondered if we could talk a little bit about that?

**Anneke Lucassen**

At CPM, we see the equity issue as broader than ancestry or ethnicity, but we have been doing some particular work about how genomic medicine and the question of ethnicity or ancestry or race has a very complex relationship. And so we've been looking at the ethical, legal and social issues that are raised by that.

**Maxine Mackintosh**

This is how actually I first interfaced with the CPM, was when I was leading the Diverse Data program at Genomics England, we set out a call to say: “let us… tell us… Help us think about all the issues to do with ethics and diversity in genomics”, in part because we were a brand new team. We didn't have the sort of musculature and skills within the team yet to answer and think about all those questions. And also by the sheer fact that thinking about diversity in genetic data is often, almost by definition means that you're looking at things that sit outside of the status quo, outside of the normal ways of working. We wanted to have some external scrutiny and advice on how to do that.

So we released a call to say: “help us think about those things”. And we commissioned the CPM, and also a mad and beautiful AI consultancy that very much took a sort of data lens on the whole thing as well. And those were two very complementary pieces of work. And for us, it provided a really useful, in-depth, thorough map for us to really understand the scope and the severity and the size of the problem that we were facing.

**Anneke Lucassen**

Equity is an issue full stop. But then in genomic medicine, you've got this very skewed dataset of our understanding of genomics being very much biased towards people of Northern European ancestry, meaning that it becomes immediately much more difficult to interpret the findings in someone who has a different type of ancestry, and that doesn't match on well, to that ethnicity information collected at the time of sampling. Partly because ethnicity is a much more complex construct than your genetic ancestry, it also involves sociodemographic factors, which then, once it's in a in a tick box, it's difficult to unpack from there.

**Rachel Horton**

And just to focus a little bit on the sort of real world consequences of this underrepresentation in genomic data sets. So I looked at the GWAS diversity monitor today, and it said 90.53% of participants were European…

**Maxine Mackintosh**

Oh, my God, it keeps going up, what the hell?

**Anneke Lucassen**

It’s worse. Yeah, it was 80 something before.

**Rachel Horton**

…so it sounds like it's not heading in a great direction, but why… do people have examples of what that means on the ground? Like, if your ancestry isn't well represented in a genomic data set, and you then have a genomic test…

**Anneke Lucassen**

The laboratory interpreting your test is much more likely to be uncertain about what those variants mean. And it's going to say- if the laboratory even knows about that person's ancestry, which, of course, they may not- it's going to say that this variant hasn't been seen before, and it might ascribe it as disease-predisposing or not, which might actually be completely wrong information, because our understanding of that variant isn't good enough.

**Nishtha Bharti**

And that’s right Anneke, and not only does that negatively impact people from ethnic minority groups, but it also significantly reduces their incentive to seek a genetic diagnosis. But on a different angle, does it also not problematise our ambition to map accessibility with ethnicity data.

**Maxine Mackintosh**

Those are really important points. There's a subtle distinction between also, once you've got the test, how that test is performant for people like you. I think a secondary question is, what proportion, what types of people, what shape of person, what background of person first presents in the first place, and therefore, how does the access to genomic services differ by certain groups, be that socioeconomic status, be that ethnicity, because that slightly makes it a bit harder to disentangle, really what's happening in the real world when it comes to the equity issues, right?

**Nishtha Bharti**

That's right, Maxine, and it's important to understand whether the demographics of those accessing a particular genomic service correlates with the demographics of the population that is being served by that service, and this can enable us to take steps towards equitability in healthcare, which is why it is important that we have robust data to map such access.

**Anneke Lucassen**

Yeah, and the bigger scheme of things, I suppose the more you have a skewed service, the more you're going to disenfranchise the people it's skewed away from, and the wider you're going to make that disparity. So we need to really pay attention to that. Because what you were saying, Rachel, is it sounds like from the GWAS diversity monitor things have got *worse* over recent years, despite people calling for better diversity and lots of global efforts to improve that diversity. I don't know if this is the right answer, but I wonder whether that skewing remains, because the established research datasets that people go to are themselves very skewed, and people keep using them, and the newer datasets that might be more diverse are less useful because they have less longitudinal data in there. So it's a sort of self-fulfilling prophecy.

**Maxine Mackintosh**

Annoyingly I can't remember the numbers off the top of my head… it's something like three to four times more likely- institutions that have existing rich data resources are three to four times more likely to then receive follow-on funding to enrich those data resources. I can't remember the number exactly, but I think it's around three to four times.

**Anneke Lucassen**

But look at UK Biobank. I mean, it's a fantastic resource, terribly useful in terms of research, but terribly skewed in terms of ancestral populations. And I think what a lot of researchers who access that do, is say, “well, we've got a 96%

white population here. Let's remove the 4% to make it a more uniform population”. And that may not be UK Biobank’s desire *at all*, but I think that happens. So that skews it even more in the wrong direction.

**Rachel Horton**

Maxine, were you mentioning earlier about some tools which sort of almost try to correct it in a in a better direction? Could you tell us a little bit about…?

**Maxine Mackintosh**

Well, I think there's a risk of coming across as like a sort of technocratic person who thinks you can sort of solve inequalities using statistics. But the way that I've always viewed this problem, which is, at the end, you've got populations who systematically, consistently and seemingly over centuries, do not benefit from the latest innovations. And so if that's the end state, then, in reality, it's made up of lots and lots and lots of failure points.

And so addressing access or addressing data collection is not going to solve it. There's a chain by which data is collected, data is generated, data is analysed, and that gets put into health systems, and then services get delivered. And you know, I'd always view it by, you're not going to solve this problem by lunchtime. It's a huge, wicked problem that is so big that you have to sort of celebrate the tiny wins, but you also have to be able to identify and articulate the tiny wins.

And so one thing that I spend quite a lot of time doing is, whenever you're faced with a really big inequalities problem, is to spend a lot of time to as precisely as possible characterise what's *actually* happening, because often it's not exactly what you think it is.

And so I love to kind of break down these big problems into a chain of events, and then try and stop a domino from falling at each one. And one that I've spent a bit more time on recently is, once you've collected your data, once you've got your dataset, once you've decided how to analyse it, there are a lot of decisions at the point in which you analyse it, where you might introduce some new biases.

**Anneke Lucassen**

Such as…?

**Maxine Mackintosh**

So we recently published a paper in Nature Review Genetics aiming to kind of characterise this whole space for people. And we came down on four main areas where statistical methods we feel play a role in improving health equity and genomics.

So one is around reducing bias, so trying to mathematically correct for unfairness in data analysis. Another one is in boosting statistical power. So with Anneke’s example, you know, often populations of non-European genetic ancestry have such a small sample size that people feel that they can just bin them, by boosting these population size, it makes it easier to detect patterns. The third category that we felt better use of statistical methods had a role, is assessing genetic variation. So this kind of challenge that everyone in a dataset is sort of genetically similar, and using more sophisticated, sort of continuous measurements of genetic variation and ancestry. And then fourth is evaluating fairness. So being really sure that when you build a model that you have really robustly done subgroup analyses, you've really seen to what extent it's performant in some groups versus others. And those are just a few ways that when you're actually *doing* the statistical analysis, you can be more thoughtful.

And for want of a better term, you know, lots of statisticians, mathematicians, data scientists, are not sitting alongside ethicists or people, clinicians or people who think about this all the time, which I appreciate is the point of places like the CPM. But there's so much bias which is *compounded* at the point of statistical analysis, which doesn't at all mean that we don't collect more data, but it can sort of act as a statistical plaster in the interim.

**Anneke Lucassen**

And misunderstanding, I think, because I've heard solutions to the problem being couched as “well, we just need to go out to some remote villages and collect some more blood samples”, as if that is a realistic solution to the whole problem. But also in the laboratory, that the mismatch between the data collection of ethnicity with sample and then looking at the genomics isn't properly recognised.

So I've heard people proposing a solution to check ethnicity by doing principal component analysis on the genetic data, as if that would give you an answer to ethnicity, when actually all it can do is give you the variations in ancestral backgrounds in that population. It's a neat, techie thing that you *can* do, but it does not map onto ethnicity at all. So that misunderstanding that it might do and that you can fill in the blank box or check whether the box is correctly filled by doing that technique, it's a clever statistical technique, but it's a huge misunderstanding of the problem in the first place.

**Rachel Horton**

And yeah, I guess so many NHS forms, it's sort of boiled down as, like, “fill in your ethnicity here, pick a tick box”, and you know, what does that mean? And how do people understand it, and fill it in? I'd be really interested to hear what you think about that, Nishtha.

**Nishtha Bharti**

So as we've just discussed, within NHS data collection systems, ethnicity is often recorded to monitor access to services and support the interpretation of genetic data. But how these categories are understood and used in practice is often unclear and inconsistent. So our findings from interviews with NHS consultants, scientists, nursing teams reveal that these categories are inadequate on two counts. The first, as Anneke mentioned earlier: ethnicity has no clear biological connotations. It is a social construct that can mean different things to different people. So when we prompt someone about their ethnicity, they might be thinking of their place of birth or their place of upbringing, their culture, their race, even their religion, and what part of their identity they choose from within this mosaic depends on who is asking that question, in what context and under what sociopolitical dynamics.

In a certain situation, certain parts of a person's identity might take precedence over other parts, but it is the sum of those parts that defines or represents that person. When patients are asked about their ethnicity, they might not have a clinician's perspective or the medical nuance to understand which part of that mosaic of identities is relevant to share and why. Instead, some of them might have had negative experiences around their identity, and as a result, might be hesitant in being transparent about it. So what we need to ask ourselves is how meaningful it is to ask patients to self-identify to a box, a box which may not fully capture the various aspects of a patient's identity, some of which might be very relevant to medical investigations.

The second count on which recording ethnicity data is problematic is that the current ethnicity categories that we see on NHS forms are exclusively geographical mappings. They do not capture global migration patterns or interracial and intercultural partnerships, which might lead to individuals having mixed biological ancestry. So assessing and recording ethnicity is rife with challenges, not just because identity descriptions are fluid, but they can also appear exclusionary and intersect with sociocultural dynamics.

**Anneke Lucassen**

And I think, some of the boxes- we know this from census information, that they can do with updating, because describing yourself as “other” is (a), not very helpful for genomic interpretation and (b), not something that you might *want* to do, yet that's often the box that many people end up ticking because they don't feel they fit into any of those categories.

**Maxine Mackintosh**

I've got two tiny anecdotes on that. One is, we did a comparison of people's genetic ancestry, what was in their box, and if you gave them free text, what they would say. There was huge concordance, which was wonderful, but the amount of people who wrote in the free text, “other” was *so* depressing, people who just internalised their poor categorisation, which is so sad.

But the little anecdote I wanted to say was exactly on some of your points, Nishtha. We ran a sort of PPI session that asked participants… this was a conversation about missing data, and says about structured missingness. So this was coming at from a statistical perspective, to say, right, if we can impute, we can fill in the gaps of this data with what we can infer about your ethnicity, we can get it pretty right, actually. And if we have this data, we're able to improve certain models by X percent. So we were able to demonstrate major clinical benefits of including ethnicity data even when it wasn't there, but we could infer it.

So we wanted to have a conversation with patients to say, “Well, what do you feel about this? That data is missing, and it's not missing at random. It's missing with structured missingness”. And overwhelmingly, the conversation was, “well, we as a community, by and large, *chose* not to give that data because we don't trust what, how it's used. And we, you know, we're concerned about discrimination. We don't know why you're asking that question, and so we've chosen not to give it to you. So what right do you have to use maths to fill in the gaps?”

And it was just a really kind of like, for me- I remember it so vividly, because even though we were able to demonstrate the life-saving impacts of including that data, that was at odds with what people felt they wanted to include, and that was, I thought, like a very good challenge, that this is such a complicated area, and you should always ask people, and the way you articulated it, Nishtha, was very poetic.

**Nishtha Bharti**

Thanks, Maxine, and it is, you're right. It is a very complicated issue, because the vulnerabilities that come with racial or ethnic profiling in larger societies do not leave us when we enter a doctor's appointment. So some of our healthcare professionals who are our interviewees have shared that some patients responded to questions about ethnicity by clarifying their immigration status. So there is an element of political vulnerability to this as well.

So there are a couple of problems when we ask people to self-identify to a predetermined and largely inadequate set of categories, because in the process, we essentially label someone who perhaps does not recognize that label as most appropriately describing their identity. So we've had interviewees, healthcare professionals, who've drawn on their own experiences, shared themselves having a very mixed biological ancestry and at a loss of which box they belong to when presented with these categories around ethnicity.

**Susie Weller**

So this very similar to some work I did a few years ago with young people looking at their kind of complex identities, and many of them are growing up in diverse communities within the UK. And it was really interesting the focus they placed on the hybrid nature of their identities, and different ways of describing their sense of belonging.

**Anneke Lucassen**

I think that's really interesting, because as we get more and more global migration, we'll have more and more of that, won't we?

**Nishtha Bharti**

So that's right, Anneke, current categories on test request forms within the NHS do not capture contemporary global migration patterns or interracial and intercontinental partnerships and multicultural children. So people could identify by their nationality, their country of citizenship, but also through their heritage or cultural or social roots. And even when patients are forthcoming in sharing their ethnicity, the categories offered on the form have proved to be restrictive, especially for patients with a very diverse background. So we've had healthcare professionals interviewees who said that in such cases, they just jotted down details of family lineage in their notes, knowing very well that these notes would not map on to the categories that laboratories require.

**Maxine Mackintosh**

I've spent a lot of time trying to think about this, and the two provocations came to me that I have found very grounding when I'm trying to make sense of a complex problem. One is Angela Saini, who is militantly against disaggregation, particularly by ethnicity. And her view is that often, when we disaggregate data, we create artificial differences between races, which themselves are artificial social constructs. So you know, her stance is you should never disaggregate.

And another one is someone said, “unless you are interested in capturing someone's experience of racism in society, you should never collect race, and it's never appropriate to use race for anything other than that”. Because often when people collect race, they're actually collecting this kind of compound of socioeconomic status and culture, and all the things that you said, Nishtha, but we don't have a nice way of capturing intersectionality, and so we use these sort of slightly mungy compounded variables.

Anyway, it really makes me think, whenever I've got race or ethnicity sitting in front of me as a variable, those two bits of advice really make me think to say, am I? Am I lazily incorporating it? Is it *really* meaningful? You know, one of my favourite papers ever was a New England Journal of Medicine paper. It's called “hidden in plain sight”. It systematically goes through a bunch of clinical algorithms and takes race in and out of them, and says, “Does it affect the performance of the algorithms?” And it's just such an interesting study, because basically, the number of times race is included in it, and it's completely meaningless and irrelevant to the clinical condition that it's being used for. And so I just found these two bits of advice useful for making sure I'm thoughtful about it.

**Anneke Lucassen**

But going back to Susie's earlier point, I think it's also really important that we don't ourselves reduce issues of equity, to issues around ethnicity or race, because, I think, particularly as medicine takes that more predictive turn, I suppose, to look at data to predict what's in the future that really skews our attention and disenfranchises socio-demographically poorer communities, so that we're spending all our healthcare resources predicting things for the affluent in society, to be rather extreme about it, but we have then less money available for those who need treating of their illnesses *now*, and I think that's a really important equity aspect that often gets ignored.

**Susie Weller**

So another example of that from the qualitative, longitudinal work we've been doing with patients and families following their experiences of being involved in genetic and genomic testing over time. What's been really interesting is the kind of disparities between access to services and resources after the test. So if a patient's living without a diagnosis or have a diagnosis of a very rare condition, for instance, they're kind of often falling between the gaps in service position. I think that's really interesting kind of knock on effect in terms of equity as well.

**Rachel Horton**

And I guess it looks in terms of our needs to have boxes to fill in and stuff to write in it. And if you can't write on a form, a kind of well recognized diagnosis, then people lose out on so much when it should be a kind of needs-based assessment of what they need, in terms of education and all sorts of things. But I guess a lot of people living without diagnoses not getting the care they need. And I suppose linking to your point Anneke about focusing so much on prediction, potentially at the expense of diagnosis. How do these efforts and focus on preventative genomics… what is the impact on people living with overt, rare conditions?

**Anneke Lucassen**

Well, I was thinking more, you know, lots of general practice attention is now on reducing cardiovascular risk, diabetes risk, keeping your blood pressure low. And there's a *lot* of attention on health checks, screening for cancer, etc, etc. And that's good, in the sense that it will hopefully catch cancer early, or be able to treat cardiovascular disease, but it's directing a lot of healthcare resources at identifying an at-risk group, rather than treating those who are presenting with illnesses. And I think that's something that some general practitioners have written about as a worrying trend, but I don't think that's hit the sort of research funding consciousness, because there doesn't seem to be any attention directed there.

**Rachel Horton**

One thing that links a little with that, maybe, but also with the genetic diversity and datasets thing, which I find really difficult is the… I guess there are a number of projects now where there's a sort of twin aim to both hopefully feedback to our participants something that might hopefully be of value to their health, like I'm thinking of stuff like newborn screening or polygenic scores, but also to contribute to knowledge around genomics.

And I think often in discussion of those, or the way it's reported in the media, you feel the kind of contribution to knowledge bit is sort of relatively underplayed in that it sounds like, “Oh, you're having this newborn screening for your baby. And as a side effect, we've got this genomic data, so we'll use that to benefit everyone”, rather than “we could do the screening without necessarily needing as much data as we're asking for”.

And then the sort of issue of people who are from groups which haven't been represented in genomic datasets, they, I guess, stand to gain less from participation in that, because the quality of the predictions you'll be able to make will be lower, because we don't have the data to draw on. But yet, it's so important that people kind of *are* included and invited to take part, if they… if they would want to. But how do you sort of avoid widening disparities while being, clear about the benefit to them might be lower than to the benefit for, you know, somebody who's got a well represented ancestral background. I'd find it a really hard kind of one to know how to…

**Anneke Lucassen**

It’s really difficult. It's part of the problem, isn't it, of doing a sort of healthcare and research venture at the same time. They're in tension some of the time, and that's a really beautiful illustration of that tension.

To some people you're saying “here, you can contribute to our data set *and* gain something from it”, and to other people you're saying, “please contribute to the data set, but you won't gain anything from it, because we don't know enough about people like you yet, but it's important that people like you join our data set, so that in the future, we'll be able to tell you something important”. And that's a really difficult balance, I think, to get right.

**Maxine Mackintosh**

When, when we were talking to people in the diverse data program about how to articulate it, we were very explicitly just a research program, so we didn't have to handle that tension- phew! But people very much told us that that was a clear and honest thing to say, “you're not going to benefit, people like you in future generations might”. And that’s the nature of this high risk and explorative research.

**Anneke Lucassen**

Yes. But I think that's fine if you're doing that to everyone. So essentially, it's what UK Biobank did. It said “we're not going to tell you anything about your own health”, apart from the immediate things that was in the initial scan,

but “this is for you to contribute to future knowledge”. And I think if you're doing that with everyone, that's fine, but if you're now saying actually, that's… we no longer do that with these big cohort studies, we've got to give people something back, but you're actually saying “we'll only give *some* people something useful back, and other people not”. That's a really difficult one to get right.

**Maxine Mackintosh**

Something that was actually quite interesting when we were trying to understand if there was anything, even superficial, we could give to people for contributing. I think my favourite was in a sickle cell group discussion, a woman said, “You know what, I want you to develop a massive partnership with Tinder. Because, hell no, am I swiping right for someone who's got sickle cell”. And she herself had sickle cell. It was, I was thinking to myself, like, actually, if we had gone down that route, more what sort of unusual creative ideas might have come up that were not clinical, didn't have high risk, but actually responded to people's lifestyle wants and needs. Who knows?

**Susie Weller**

Another aspect of intersectionality that I think is really interesting is gender. And some work that we done with a panel of public participants was around how people see personalised medicine in terms of personalised care. And we had some really interesting and moving accounts from women, particularly who talked about poor experiences of personalised care, in different aspects of the health service. And I think that's another really interesting issue that deserves attention.

And the quality of relationships and interactions was key, that's what made something *feel* personalised to women, and it was really interesting to the accounts that, often reflecting back over a lifetime of experiences of care,

the disparities they felt between their experiences as women and the way they were treated as women.

**Rachel Horton**

Of all the themes, like, this is, I guess the one I felt most nervous talking about in some ways, just because you feel like I don't know… I kind of feel like it's okay for me to know nothing about economic sustainability and to get all the words wrong, and to be kind of… but about equity issues, you feel it's so important and it impacts people, and often people who've been kind of really badly served in the past and things. And you feel this sort of anxiety to, like, get it right, but not know quite how to get it right.

**Maxine Mackintosh**

I think that is such an important point. I've been working on equity and data for like, the last 12 years now. And overwhelmingly, when you do a podcast, you do a talk, and then people come up to you at the end and say, “I just don't know where to start”, or “I don't want to come across as racist”. Or like, “I don't want to, you know, get cancelled”. Or, like, “This feels like the top of the culture wars”, and it's this environment of fear that means that people aren't happy to share that they're on a journey, or they're experimenting, or, you know, say stupid stuff, or use the wrong words.

I think this is such an important point, because we need to make it okay for people to be at any stage of the journey to understand this, explore it, make sense of it. And if someone uses the wrong word, there are bigger things in life to pay attention to, you know, understand the intention behind it. And I don't think we make it super easy for people to slightly mess up and forgive, in an environment which is technically complex, scientifically complex, ethically complex, morally complex.

**Nishtha Bharti**

That's a good point, Rachel, and we have been thinking about how to bring together various interest holders in conversations around ethnicity and identity descriptors in general.

And we've recently organised an event called “Thinking outside the box”, which brought together patients, healthcare professionals, scientists and policy makers to explore identity descriptors, such as race, ethnicity and ancestry, how they are used in healthcare, particularly in genomic medicine. The methodology we used for this very interesting event was called public switching, where we encouraged participants to co-create more inclusive, contextually grounded recommendations for healthcare professionals and policy experts. Our intention for this particular event was to reverse conventional rules and bring in the lived experiences of patients into direct conversation with our research findings, which we discussed earlier.

**Maxine Mackintosh**

So I think that’s a really important point, which is who makes the decisions, who contributes to this discussion? Because it warrants input from all sorts of people, Nishtha, that you've outlined, and we're about to start, with Data Science for Health Equity, this kind of large community of people with deep domain expertise in data science, AI machine learning, teamed up with people who have kind of frontline problems on health equity.

We've got a two-year CRUK grant kicking off, which is all around: “How do you give practitioners in this space the tools, the resources, the support they need so that they work more equitably with data?” And our kind of line is “to make it too easy not to do”, because we know that there's loads of reasons why you might bin a certain population, or you can't be bothered to find the latest model that's more ancestry aware, or whatever it might be? And a lot of these are run as kind of big online, collaborative events, and trying to get kind of crowdsourcing of lots of stuff. But really, our view is that the knowledge is in the masses, and we just kind of try and synthesise it and compile it so that people find it useful. So we're about to kick that off as well. So there's lots of different ways for people to kind of get involved if they want to deep dive into this topic more.

**Rachel Horton**

Thank you for joining us for this episode of the Centre for Personalised Medicine podcast. It's been a really interesting discussion. There's lots of work going on at the CPM that touches on this theme. Please take a look at our website to find out more.