Personalised medicine has the potential to optimise drug efficacy and patient outcomes as well as save the NHS billions. Professor Sir Munir Pirmohamed talks to Kate Stewart about his groundbreaking work in this field.

Since leading physician and pharmacologist Professor Sir Munir Pirmohamed qualified as a doctor, he has worked over 80 hours a week in his bid to reduce drug wastage in the NHS, improve drug treatments and reduce the burden of adverse drug reactions on patients.

His love of Arsenal and fast cars have rarely got a look in as his lifetime passion to make drugs more efficient and effective for patients across the UK has driven his career forward.

Professor Sir Munir Pirmohamed studied medicine at the University of Liverpool and that is where his love of pharmacology began. He says: “I was fascinated by medicines and how they worked. I remember as a medical student seeing a patient in A&E who had been brought in with a heroin overdose. The doctor gave him naloxone and it was a ‘wow’ moment for me to see the patient wake up as a result of receiving a drug that antagonised the overdose he had taken. The power of that is what attracted me to this area of medicine.”

Professor Sir Munir Pirmohamed is now the David Weatherall chair of medicine at the University of Liverpool and honorary consultant physician at the Royal Liverpool University Hospital. He is also the associate executive pro vice chancellor of clinical research for the Faculty of Health and Life Sciences.

He holds the only NHS chair of pharmacogenetics in the UK and he is director of the Medical Research Council (MRC) Centre for Drug Safety Science, director of the Wolfson Centre for Personalised Medicine in Liverpool and executive director of Liverpool Health Partners.

He was awarded a Knight Bachelor in the Queen’s Birthday Honours list in 2015. He is also an inaugural National Institute for Health Research (NIHR) senior investigator, Fellow of the Academy of Medical Sciences in the UK and a commissioner for the Commission for Human Medicines (CHM).

Professor Pirmohamed’s research focuses on personalised medicine – in which medicines are tailored to the individual patient based on their risk of disease or predicted response – in order to optimise drug efficacy and minimise toxicity, which costs the NHS over a billion pounds a year, he says.

Professor Pirmohamed adds: “I trained as a clinical pharmacologist and work as a physician in the NHS. When you are giving drugs to patients for the treatment of diseases from epilepsy to hypertension, you know that some patients are going to respond, other patients are not going to respond and some patients develop side-effects. Clearly there is a lot of variability and my research has centred on identifying the reasons for the variability and then trying to develop solutions to overcome this, so that any patient you give a drug to responds and doesn’t get side-effects.”

Professor Pirmohamed’s research focuses on the harms and benefits of medicines including those used in cancer in order to personalise healthcare. A multifunctional approach is undertaken to evaluate and quantify these harms and benefits with the aim of developing evidence-based strategies to optimise the risk/benefit balance.

The research requires the use of many different methodologies, from health service approaches to translational methods (bench to bedside and back). The research is aimed at filling in all four translational gaps (clinical validity, clinical utility, implementation and public health impact).

Personalised medicine is a term that is used a lot nowadays, but does it have a role in primary care? Professor Pirmohamed says: “Stratified or personalised medicine is integral to every part of the healthcare system including
primary, secondary and tertiary care.” He urges those working in primary care, where most prescribing is done, to ensure stratified medicine is introduced.

Professor Pirmohamed has been encouraged by the work he has already done with GPs. “There is a whole spectrum of views from those who are very enthusiastic to those who just don’t believe it. But people are interested and want to know how it will work and we have already discussed where there are opportunities, hurdles, challenges and solutions, and hopefully this will help provide a pathway for GPs going forward.

“There are many issues to tackle – the ever-increasing drugs and social care bills and the ever-growing elderly population. We need to think about different ways we can use technologies – whether they are genomics, sensors or personal data – to refine the way we manage patients to make sure they are getting the right treatment for the best outcomes for them.”

We need to make sure patients understand the limitations of genetic testing and as prescribers, we need to be ready for patients who have genetic information that could influence the drugs we prescribe.

Genetics and genomics have promised a lot, but have still not found their way into mainstream clinical practice. What are the reasons for this, and how long before we start to see more widespread use?

Professor Pirmohamed explains that the first reason for this is that some technologies have only recently been developed and the investigations are expensive, although they are now coming down in price.

He adds: “Lack of knowledge in the community is a major issue and as we move forward with the genomics revolution, it is important that our doctors, nurses, pharmacists and health professionals are better trained in the potential use of genomic technologies so they can use them as part of a critical evaluation of their patients.”

Professor Pirmohamed points out that genomics has already found its way into certain areas – particularly in the treatment of cancer and rare diseases as well as drug safety – and he predicts it will slowly make its way into “all different areas of medicine”.

He remarks: “Everybody is focusing on genomics but genomics is just one aspect of personalised medicine; there are many other ways of incorporating other factors to make sure that we practice personalised medicine.

“A patient’s diet and exercise regime is also important; with many people now using wearable tracking devices such as Fitbit, such data can be fed into the personalised medicine agenda and be part of the drive towards a healthier lifestyle. This means patients can very much be a partner in this journey, which is a collaboration between the patient and their doctor. Collecting data from the patient and putting it together with the patient’s own genetic material plus their medical history and medication allows us to be able to say this is the best treatment for them.

“Now that does sound like science fiction at the moment but it is already happening in some areas and it will start occurring in many more areas in the future,” Professor Pirmohamed predicts.

What are your thoughts on the 100,000 Genome Project, which will sequence 100,000 whole genomes from NHS patients with rare diseases and their families, as well as patients with cancer?

Professor Pirmohamed says: “It’s fantastic that the UK is doing this very ambitious transformation project to get genomics into mainstream clinical practice. Having the whole genome sequence for an individual and then making that data available to the NHS is already making a positive difference in certain areas, particularly with some rare diseases where it was previously impossible to make a diagnosis.

“For example, there’s a rare deficiency of a particular gene called GLUT1, which causes seizures and epilepsy from childhood. Some patients who have had their genome sequenced have been shown to have this mutation. They have been put on a ketogenic diet and this has been able to reduce or stop the seizures altogether.”

He adds: “There will be more stories like that in the future, including identifying many new genetic mutations in cancer, which will, hopefully, also lead to new drugs being developed for those cancers.”

What are the key clinical or therapeutic areas where you think genetics could make the biggest difference to patients?

“Cancer, rare diseases, drug safety, cardiovascular disease and diabetes are the key areas so far but I think other genetic technologies such as pharmacogenomics, which can work across different disease areas, are also important,” notes Professor Pirmohamed.

Genetics now plays an important role in modern drug development. Cancer treatment is probably the most obvious area, but what about other areas, such as antibiotics?

Professor Pirmohamed responds: “There are new drugs coming through for the treatment of heart disease, osteoporosis and high cholesterol that are all based on genetic data.

“In the future, we should also be able to identify which particular species of bacteria is infecting a patient much more quickly by using genomics and also identify whether the bacteria have any particular mutations that make them resistant to particular antibiotics. This will enable us to choose the right
antibiotic for the patient to try to overcome resistance.”

He adds that this will also help stop the inappropriate use of antibiotics to treat viral infections as well as reduce antimicrobial resistance. “Imagine a future where you can diagnose specifically whether it’s a viral or a bacterial infection and then give the antibiotic to those people who actually need it rather than to everybody, like we do at the moment.”

How should we go about improving training/education for clinicians in the areas of pharmacogenetics and genomics, and how important is this training?

Professor Pirmohamed has extensive experience of teaching medical students, including lecturing, tutoring and bedside teaching. He has also successfully supervised 45 students for higher degrees.

He insists that education needs to start “before a student starts university”. He adds: “We need to see much more genomics and genetics education in the school science curriculum. My son has just finished his A-levels and I was pleased to see how much they were being taught about genomics and genetics in school.

“This needs to be followed up in the undergraduate curricula so clinicians of the future are well prepared for the genomic revolution as well as making sure we support those who specialise in this area, who need continued professional development.”

Professor Pirmohamed believes that future clinicians do not need to be experts in genomics but they would need to understand how such information can help them treat some patients and how to refer a patient speedily to a genomics expert.

He continues: “Genomics is advancing so rapidly and becoming so complicated that nobody will be able to have knowledge of every area because of the vast amount of data. So we will also need decision support systems on our computers to help us make the right decisions for any particular patient. These will look at individual genetic characteristics and make sure we prescribe the best drug available for that individual.”

These decision support systems are being developed for NHS use but are still in their infancy, he adds.

Concerns are sometimes raised about privacy issues surrounding the use of genetic data. Are these well founded? Who should have control of this sort of data – the patient, primary care, hospital geneticists, or someone else?

Professor Pirmohamed stresses that it is crucial that all patients have confidence in the privacy and confidentiality of their data and that if you sequence somebody’s gene or genome then it is “their data”.

He explains: “If genetic tests are done, they are kept confidentially in the hospital or primary care record and I assume that will be the model used in the future. But it is also possible that as we move forward and patients become more empowered, they will hold their own genetic data as well as
clinical data. I don’t have a problem with that. Genetic data is like any other test and if the patient carries the data to share with all the relevant experts, this prevents expensive, duplicate testing and gives the clinician the chance to make a faster diagnosis.”

**Does genetics have a role in routine clinical practice for improving drug safety, or should we be concentrating on addressing basic issues such as prescribing errors?**

Professor Pirmohamed says: “Prescribing errors need to be reduced and we need all these elements in place to make that happen. Genetics can help make sure the patient is getting the right drug and the right doses to prevent a serious adverse drug reaction but it is not mutually exclusive. It’s part of the overall holistic approach to treating the patient.”

**How does direct-to-consumer genetic testing potentially have an impact upon prescribers?**

Professor Pirmohamed believes consumer genetic testing is becoming more widely available and should not be ignored. Many people use it to determine their ancestry but sometimes people want to discover their potential predisposition to certain conditions. “It is all part of the patient empowerment pathway that we are undergoing at the moment,” he observes.

“We need to make sure patients understand the limitations of genetic testing and as prescribers, we need to be ready for patients who have genetic information that could influence the drugs we prescribe.”

He cites the example of the anaesthetist whose patient informed him he was deficient in a certain enzyme, which meant he could not be given a certain type of anaesthetic. Had the patient received the wrong drug, it could have caused prolonged paralysis.

Professor Sir Munir Pirmohamed has authored over 420 peer-reviewed publications and has an h-index of 85. With such a long list of achievements to his name, many of which are not mentioned here, is there one achievement that he is especially proud of?

He responds: “Being awarded a knighthood was a very great honour – it was recognition not just for me but for my whole team and the work that we do, which is far too complex to do by oneself.

“Other highlights include qualifying in medicine, getting my PhD and getting my first paper published. It’s still a thrill getting a paper published even after over 400 publications. That’s why I stay in science – it’s not only about identifying new things in laboratories; it’s about how I can take that new discovery to patients in terms of developing new drugs and diagnostic tests,” he concludes.

**Declarations of interest**

None to declare

Kate Stewart is a freelance health journalist