



# When the **chemistry** is right

LATERAL THINKING AND A PENCHANT FOR PLAYING DETECTIVE WILL STAND ANYONE CONSIDERING A CAREER AS A CHEMICAL PATHOLOGIST IN GOOD STEAD, WRITES LISA MITCHELL.

PHOTOGRAPHY: PAUL JONES AND EAMON GALLAGHER

“In a way, we are guiding the doctors,” says Dr McNeil. “The advantage we have is that all the results come in to one place. This repository of knowledge is an invaluable aid to clinicians.”

Of the thousands of chemical pathology tests processed in a laboratory each day, perhaps 50 results will demand further detective work from experts such as Dr Alan McNeil, the chemical pathologist at Dorevitch Pathology in Melbourne. Dr McNeil likes to scrutinise all positive pregnancy results for men, for example, before delivering their happy news.

Silly computer, confusing its genders again. But there is more to this than a mere mix-up: a positive pregnancy result for a male might indicate testicular cancer or the detection of an over-ambitious athlete.

The presence of the hormone hCG in the blood test of a woman confirms a pregnancy, but hCG is also produced by some testicular tumours, and some athletes use hCG to illegally enhance their performance, says Dr McNeil. It certainly pays to be a lateral thinker in his profession.

Unlike anatomical pathologists, who examine tissues and cells, or microbiologists, who focus on viruses, bacteria and parasites, chemical pathologists are concerned with measuring concentrations of substances in the blood and other bodily fluids such as urine or saliva. Most testing is done on serum, which is obtained by separating whole blood into its components, says Dr McNeil.

“The serum is the fluid that bathes the cells in your body . . . and its composition is tightly controlled by hormones and various physiological balance mechanisms . . . but if it (the composition) deviates and becomes too salty or acidic, it usually means there is something strange going on in the cells. It tells you that the metabolism, or those control mechanisms, have become defective.” Damaged cells will also release substances into the serum, providing further clues that help to predict or diagnose heart attacks, for example, Dr McNeil says.

Chemical pathologists are the people we can blame for banishing cakes and ice

cream from our daily diets when their tests reveal high cholesterol levels. They often deliver the unwelcome news of diabetes after measuring blood sugar levels and are the ones who nudge patients from denial into action: there’s no evading your drug or alcohol problem when these bloodhounds are on duty.

Microscopes have no place in the laboratory of a chemical pathologist. Instead, there are whirring computers and analysers set up to perform tests and use algorithms to produce results in the form of numerical data. These information systems spit out as many as 150,000 biochemical results on 9,000 patients a day in some laboratories.

The “Modular”, for example, analyses cholesterol and performs liver function tests, while the “Centaur” machine busies itself with hormone testing. The GC/MS (Gas Chromatogram/Mass Spectrometer) nabs drugs of abuse and screens for toxicology. Each Modular report contains up to 25 test results – depending on what the doctor has requested, and the lab may report anything from one result (say a glucose reading) to the full list.

Dr Charles Appleton, the pathologist in charge of biochemistry at Queensland Medical Laboratory, says that because of the volume of reports processed each day, most are sent out with computer-generated comments or with no comment at all where the result appears to speak for itself. When anomalies arise, however, chemical pathologists speak with the clinician who has requested the test to try to figure out the bigger picture.

“If I can look at a report with, say, abnormal calcium and parathyroid hormone levels, and see that the pattern suggests the patient has a Vitamin D deficiency, that will give the doctor some direction as to where the testing could go from here,” Dr Appleton says.

Chemical pathologists are practised in many tongues since they spend much of their day discussing unusual results across the medical community, with everyone

from GPs and kidney specialists to neurologists.

“In a way, we are guiding the doctors,” says Dr McNeil. “The advantage we have is that all the results come in to one place. A GP may see a case of overactive thyroid caused by Amiodarone, one of the heart medications, or something relatively rare like lead poisoning, once a year, but we tend to see all of those cases.” This repository of knowledge is an invaluable aid to clinicians, he says.

Often, Dr Appleton’s contribution is to rule out a diagnosis, rather than to confirm it. He recalls the recent case of a four-week-old baby producing green faeces, a phenomenon which could not be attributed to the normal release of meconium in the days following birth. He discussed the baby’s recent history with the maternity health nurses.

“There are a lot of things that can cause babies’ faeces to change colour but of those, only a couple are really worrying, and because this baby was in very good health there was no point pursuing extra testing. I recommended just keeping an eye on the baby, and not causing the family any further anxiety by continuing to investigate it.”

Having this level of expertise on tap means many GPs can service some of their patients for longer, providing continuity of care. Referring patients on to specialists can be a lengthy process that increases patient anxiety.

“It’s all very well to write repeat prescriptions and look after ingrown toenails . . . we know a lot of doctors like to hold on to their interesting patients . . . If the patient does need to go on to a specialist, however, they have a far more detailed work-up to take with them,” Dr Appleton says. “The most rewarding thing I can do is to take a call from a doctor who has a perplexing patient presentation that we may be able to resolve over the phone. Or we can at least come up with a list of possible diagnoses and further tests to carry out.”

*Dr Alan McNeil in the Dorevitch Pathology laboratory in Melbourne.*



Because chemical pathology testing is largely automated via information systems, fewer specialists are required in the field. It doesn't take much to drain the pool of expertise however – a few retirements here, an overseas appointment there. To date, there are 68 chemical pathology fellows registered around Australia and 10 trainees.

Dr Graham Jones says it took him about 20 years of training to become a chemical pathologist.

"I went straight from high school into medicine, then took a year off to do a Bachelor of Science (Medical), then later took another five years off to do a PhD in biochemistry . . . At school, (studying) physics and chemistry, the biological sciences hadn't yet opened up, but in the pre-clinical years of medicine I suddenly saw how fascinating the body is. The science associated with biology was a

tremendous eye-opener for me. It wasn't until fairly late that I identified pathology as a career option, probably towards the end of final-year medicine."

The five-year chemical pathologist's course run by the Royal College of Pathologists of Australasia must be completed in an accredited environment, such as one of the large teaching hospitals or a large private laboratory. Trainees are not allowed to spend more than four years in one institution, however. During those five years, up to one year may involve clinical practice in a relevant discipline or training in another discipline of pathology.

Some applicants may receive credits for completed PhD work, and up to two years of full-time clinical or laboratory-based research (as part of an approved higher degree) may be counted as part of the five-year requirement. The qualified chemical pathologist combines not only an

investigator's nous with a scientist's knowledge, but can also handle the efficient administration and management of a laboratory and is adept with information systems and data analysis.

While all chemical pathologists are "generalists" in the sense that they communicate their results to doctors across diverse fields of interest, many develop their own areas of expertise such as inherited diseases, gastroenterology or nutritional disorders. Dr Jones has honed his knowledge in the areas of diabetes and renal and cardiac medicine.

"Heart disease is still the No.1 killer," he says, "and with kidney disease, patients are absolutely reliant on our tests for monitoring (their wellbeing) . . . They are not static areas, it's not as though you learn it once and know it . . . you might be considering new ways of measuring or monitoring things, discussing the best measurement protocols, or looking for factors that might make a test more, or less, reliable."

There is, for example, a tremendous new blood test that can predict heart failure, says Dr Jones. The B-Type Natriuretic Peptide test might eventually reduce the number of expensive echocardiogram tests being performed.

"It has been fairly widely adopted in some countries but the implementation of a brand new type of testing, at best, takes five or six years . . . when you think about the education involved, trying to identify the questions that should be asked, and whether such testing would be useful and, if so, for whom," Dr Jones says. "Then you have to gain the expertise in clinical interpretation and bring it into routine use so that any doctor might request it."

The caseload of chemical pathologists day to day is deliciously unpredictable. In so many careers, ringing telephones signify unwelcome distractions by insatiable taskmasters. But chemical pathologists such as Dr Appleton consider each new phone call a potentially exciting enigma for deciphering.

"When the phone rings, that is what drives me." 🔥



*Dr Graham Jones finds the body fascinating*

## New developments

By Lisa Mitchell

Chemical pathology is often peering over the precipice into valuable scientific discoveries and potentially controversial applications. When Victoria Police recently introduced random drug testing for drivers based on saliva samples and one of the first drivers tested returned a positive result, the media pounced. The driver immediately had an independent analysis done that proved negative, creating a flurry of radio debate and news headlines.

While the pathology community supports detection of drug abusers, it is divided on the place of saliva testing as opposed to the well-standardised urine testing.

“We are not yet as confident with the interpretation of saliva tests as we are with urine testing in the sense that we are still learning how likely different drugs are to cause positives, and for what

time after use the finding may be expected to continue,” says Dr Charles Appleton, the pathologist in charge of biochemistry at Queensland Medical Laboratory.

Any driver who has ingested quick fixes such as Sudafed or cold and flu tablets may test positive for drugs, Dr Appleton says. Because there is no way to confirm the illegal or therapeutic nature of drugs by the roadside, drivers may be open to being unfairly penalised in the interval before confirmation or clarification can be made.

“There are also various standards for testing . . . and while there is an Australian standard for urine drug screening, there is no standard yet for saliva. Without a standard, the tests will be more open to challenge in court,” says Dr Appleton.

Separately, a positive development has been seen in the field of protein research. Scientists have found that they can

examine the protein fingerprint of cells in minute detail using a modification of the GC/MS (Gas Chromatogram/Mass Spectrometer) that is used to detect drugs of abuse. This relatively new Tandem Mass Spectrometer (Tandem MS) technology, along with DNA testing, may give a more direct picture of what is going on inside cells, rather than merely analysing the soup in which they bathe.

Ultimately, this testing could be used to tailor drug treatment to individuals, helping people to receive the medication that best suits their system, and to avoid medication that may do them harm. These methods are already used in the diagnosis of genetic diseases and for the early detection of cancer, while Tandem MS technology has also revolutionised screening for diseases in newborns. 🔥