New blood tests allow early cancer diagnosis

RESEARCHERS in the Monash department of pathology and immunology have developed a testing program which detects early signs of bowel cancer.

It is already being used in extensive field trials to recognize recurrence of this type of tumor in post-operative patients—before clinical symptoms appear and before detection is possible by traditional methods.

The early warning system will boost chances of successful treatment by alerting doctors to attack the recurrence at the earliest stage.

Head of the department, Professor Richard Nairn, says the basic procedures are usually applicable to detecting other types of cancer.

"We are using much the same tests for skin cancer, including melanoma, and for some other common human cancers," he adds.

"However, until our methods are perfected, it is sound scientific practice to confine our field trials to one main area—bowel cancer—while continuing to look at other areas to obtain comparative data."

"Such data will provide an excellent springboard for developing the application of our tests to cancer diagnosis in general.""

The testing method is a product of extensive studies by the department of pathology and immunology into the body's natural immune reactions to invading cancer cells.

It is believed to be the only research unit in the world to have adopted such a technique as a routine clinical laboratory test.

The department is part of the Monash Medical School attached to Melbourne’s Alfred Hospital. Its work is funded by grants from the Anti-Cancer Council of Victoria and the National Health and Medical Research Council.

Nairn says the cancer recurrence tests have now been adopted as a routine procedure in the post-operative care of all bowel cancer patients referred for immunopathological studies to his department.

The method has proved successful in monitoring the condition of patients who have been operated on for bowel cancer by a number of surgical colleagues, in particular members of the Monash department of surgery, headed by Professor E. S. R. Hughes, and senior surgeons Mr. Alex Rollo and Mr. Alan Cuthbertson.

Most of the patients have been operated on at the Alfred Hospital, St. Frances Xavier Cabrini Hospital, and The Avenue Hospital.

The tests start about two months after the primary tumor is removed and are repeated at intervals of two to three months.

Should a resurgence of the cancer be detected, the patient may be recommended for further treatment such as radiation therapy, chemotherapy (drugs), or surgery.

"The possibility of a very sophisticated adjunct to treatment—immunotherapy (a kind of vaccination)—is contemplated in the near future," says Nairn.

Besides direct recognition of tumor cells in the body, some of the tests can show the presence in the blood of cancer material derived from such tumor cells.

Because each test involves at least 24 man-hours work by highly-trained staff, they are not at present economically viable as a mass screening procedure, Nairn says.

But new testing methods still being evaluated promise quicker results.

A major weapon in the department’s present clinical diagnostic arsenal is a test carried out by senior lecturer Dr. Erik Pihl with the assistance of Mr. Antony

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Antigen reaction

A reaction takes place in the three-way mixture in which tagged cancer antigens and any from the patient's blood "compete"for the antibodies from the rabbit. This yields a precipitate and its level of radioactivity can be measured against that in a mixture containing only rabbit antibody plus tagged antigen from the tumour.

While effective in some cases, the test's complicated procedures, including incubation periods for cultures, takes about a week to complete.

This drawback might be overcome by a new testing method recently developed by members of the research team. This takes only a few hours to produce a result, but has yet to undergo field trials.

The new system, developed by Professor Nairn, lecturer Dr. Jennifer Rolland, and honors student Greg Ferrier, has given encouraging results in animal experiments.

"There is no reason to suppose it will not be just as effective in detecting early signs of human bowel cancer," says Rolland. "We will start testing this in the near future."

All the detection methods are based on three bodily reactions to cancer—

- The production of the white blood cells called lymphocytes which specifically attack tumor cells.
- The presence of cancer-attacking antibodies (chemicals produced by lymphocytes).
- The liberation of cancer antigens—substances which trigger off the body's immune response to the cancer.

"The suggestion that cancer could provoke an immune reaction in the human body was once mocked," says Nairn.

"It was considered an impossibility on the grounds that the tumor cells were a part of the body. Now it is accepted that cancer is foreign to the body—sufficiently foreign for some measure of immune attack to be commonly mounted against it.

"Perhaps if it were more foreign this attack would be intensified and the tumor rejected in the same way as, say, a kidney transplant is rejected.

"It could be that some small tumors ARE rejected by this means and we remain unaware of the fact."

"Rejection can be induced in animals by implanting a tumor, removing it after a time and then putting it back again. It will be rejected the second time because a sufficient immune response was provoked during the first exposure to the tumor."

Ethical and moral restrictions prevent such "immunization" techniques being tested on humans, says Nairn.

He says public attitudes towards cancer are too pessimistic.

"Skin cancer, if not neglected, is now almost 100 per cent curable. Bowel cancer—now the most common type of tumor in the western societies and still on the increase—is curable in four out of five cases, if caught at an early stage."

The new time-saving detection technique developed by Nairn, Rolland and Ferrier will involve studying the reactions of lymphocytes when they are brought in contact with bowel cancer cells.

Lymphocytes from a patient's blood are first treated with a fluorescent dye called acridine orange and then mixed with tumor cells. Acridine orange fluoresces green at low concentration and red at high concentration.

The reaction is examined with the department's fluorescence microscope—one of the most sophisticated in the world.

Each lymphocyte contains a number of "stomach"-like bodies known as lysosomes.

Color change

Normally, lymphocytes fluoresce green from the dye they absorb, except for a few lysosomes which take in a greater amount and show up as red dots.

If some of the lymphocytes happen to be anti-cancer ones, produced because the patient's body is trying to fight a cancer, they will "recognize" and "attack" the tumor cells in the mixture.

This, for reasons not yet clear, causes a marked change in the lysosomal membranes of these lymphocytes and many more of them absorb dye and fluoresce red.

"While we have adopted the technique for future field trial as a test for bowel cancer, it should work just as effectively as an indicator of lymphocyte reaction to any antigen in many diseases," says Rolland.

A description of the new method has been accepted for publication in a leading international scientific publication, the Journal of Immunological Methods.
Sun theory to set experts arguing... 

CALCULATIONS by a Monash mathematician suggest the sun has a "dead heart"—a burnt-out core about 60,000 kilometres in diameter.

And computer results seem to confirm he has his sums right.

The discovery is part of a new theory developed by lecturer Dr. Andrew Prentice. He believes it holds the key to how life on Earth suddenly and mysteriously blossomed some 570 million years ago.

"If I'm right, all accepted theories of stellar evolution will have to be revised," Prentice says.

His claims are already causing controversy in world cosmological circles. He was able to explain them recently at a NATO Advanced Study Institute conference in England on the origin of the solar system.

Prentice was the only delegate from the Southern Hemisphere invited to the meeting, at which leading cosmologists in the fields of physics, chemistry, astrophysics and mathematics discussed their common interest.

A detailed paper on his findings is about to be published in a European journal on astronomy—Astronomy and Astrophysics—which is jointly produced by scientific publishers in France, Sweden, Holland and Germany.

Oxford support

Independent calculations by a Monash graduate, Dr. Andrew Bolton, who is now working at Oxford University, support the Prentice proposition.

Present theories suggest that since the formation of the solar system (4500 to 4700 million years ago, according to tests such as radio-carbon dating of rocks and meteorites) the sun has been steadily burning its nuclear fuel.

This would imply, among other things, a generally uniform heat output to warm the Earth and other planets.

But geological studies of rocks known as pre-Cambrian indicate that for an unknown period up to 570 million years ago the Earth was in the grip of a global ice age.

Temperatures were at least minus 10 degrees Centigrade and possibly as low as minus 30.

Pre-Cambrian rocks contain no fossils apart from single-cell, non-reproducing forms such as blue-green algae.

Then, suddenly, the fossil evidence shows, the Earth's temperature rose to present-day levels that could initiate and support multi-cell organisms.

It heralded the start of 'real' life.

This has left scientists with a puzzle: why such a vital, dramatic change in Earth temperature occurred if, in fact, the sun's rate of burning remained unchanged.

The answer to that puzzle, says Prentice, is that the burning rate has NOT been constant and in fact underwent a massive change which brought about the life-giving Cambrian period.

And while it gave life to the Earth, it gave the sun its dead heart, he claims.

Prentice stumbled on his answer to the puzzle while studying neutrinos, one of the group of elementary particles of matter. Neutrinos come from the nuclear reactions in stars and nearly all those that reach Earth come from our star—the sun.

Explantion

Like many other scientists, Prentice was trying to find out why the flow, or flux, of neutrinos from the sun is today very much less (about a fifth to a tenth) than would be expected from a star of its age.

What he theorised—and says the computers have confirmed could have happened—is that at first the sun possessed a central core rich in carbon, nitrogen and oxygen compared with its surrounding envelope, which is mainly hydrogen.

While the core fiercely consumed its own comparatively small store of hydrogen, it expanded greatly, getting hotter at the centre but cooler on the outside (though still within its hydrogen-rich envelope).

Prentice links that cooling of the outside of the core to the pre-Cambrian freezing of Earth.

But about 570 million years ago the central core burnt out and collapsed inwards to form a dense nucleus of constant temperature, he says.

The hydrogen-rich outer envelope, previously partially isolated by the cooler outer limits of the burning core, was then free to rush in and fuel the central inferno.

This would have raised the temperature at the outer edge of the envelope by about 1000°C to its present 6000°C.

Reduce flux

Prentice says his sums and computers tell him that one outcome would be to double the luminosity and therefore the radiation from the sun. That, he believes, ended the pre-Cambrian global ice age by raising the Earth's mean temperature to near its present level of about 14°C.

Such a sequence of events, he says, would also reduce by 80 or 90 per cent the flux of neutrinos from the sun, accounting for the normally low numbers now reaching Earth.

This is because neutrinos, which are very temperature sensitive, mostly originate from the centre of the sun.

"According to my calculations, present temperatures at the edge of the core are about 14 million degrees Centigrade rather than the 15 million degrees estimated in earlier theories," he explains.

"And it has been proven that the flux of solar neutrinos drops by a factor of six compared with a drop in temperature.

What this means is that a drop in core surface temperature from 15 to 14 million degrees would reduce solar neutrino units reaching Earth from six to one. And this is in fact the reading now being recorded here and which is puzzling scientists."

While the "dead-heart" theory offers mathematical explanations for Earth's pre-Cambrian "deep freeze" and the big thaw of 570 million years ago, Prentice says it also offers Earth a longer life.

"If, as my calculations suggest, the sun's core surface temperature is a million degrees lower than previous estimates, this means it will take longer to burn up the remaining nuclear fuel in its envelope.

"Until now it has been estimated that it was about half way to burning itself out, with about five billion years to go.

"But on my figures, it will last an extra two billion years."
Hormone link in stress diseases

It is known that during the late winter mating period the males become extremely aggressive, the Monash researchers report. There is a great increase in their wandering habits and in "interactions" (confrontations between males which sometimes lead to actual fighting). Copulatory activity is frequent and prolonged. These mating habits were found to be associated with increased activity in the cortex, or outer layer, of the adrenal glands, which in all mammals are located adjacent to the kidneys and produce hormones, related to the sex hormones, called corticosteroids. The result was a boost in the concentration in the blood plasma of a steroid hormone called cortisol. But this by itself could not be pinpointed as the cause of the love-and-death cycle, because females captured at the time of male mortality also showed an increase in plasma corticosteroid concentration. Yet it is known they survive at least long enough to rear their young—about another three months—and in some cases long enough to bear again the following year. And males captured and isolated before the mating season are often able to survive despite their plasma corticosterone level being artificially raised by injection.

Even when the concentration was boosted to well above the natural breeding level, the mortality rate was only 45 per cent. However, the researchers found that males in natural breeding surroundings are affected by a second change in their blood chemistry not shared by the females. While the plasma corticosteroid concentration went up, there was a dramatic drop in the level of a special protein in the blood, called transcortin, which firmly "binds" corticosteroids and unloads them only in the tissues which are using them most. The system protects the rest of the body from unwanted actions of the corticosteroids and prevents big fluctuations in the "free" or active blood corticosteroid level during stress. The result of the two changes in males, the researchers found, was a four to sixfold increase in the level of dangerous "free" corticosteroids in the blood.

Confrontation

This "hyperandrenocortisism", they suggest, is the direct result of males suffering the confrontation stress of the mating season—a behaviour pattern initiated by their male sex hormones. It leads to excessive use of the protein reserves in the body, normally mobilised only in response to injury or other stressful conditions, and a disturbance of sugar production and usage resembling diabetes. It also leads to suppression of the immunological defences of the body, permitting the fatal invasion by micro-organisms and other parasites.

The condition is similar to a human malady called Cushing's syndrome, caused by adrenal gland dysfunction, or by administration of large doses of corticosteroids—for example, to prevent re-

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A MONASH expert has discovered a treasure trove of rare and valuable ethnic music instruments among exhibits stored in the vaults of the National Museum in Melbourne.

And she suspects more are waiting to be discovered in other museums around the country.

The find was made by Veronica Rosier, an M.A. student in the University's department of music.

After extensive studies in Europe last year, Rosier qualified as the only person in Australia specifically trained in the "curating" of musical instruments.

She identified the rare specimens in the National Museum vaults while cataloguing the collection of about 450 ethnic music instruments in the museum's anthropology section. These date from a Fijian "trumpet", made from a large triton shell, which was collected in 1881.

The job is the first step in a mammoth project to catalogue as many as possible of an estimated 5000 instruments—European and ethnic—scattered around the country in public and private collections.

Few on show

About 150 of the National Museum collection are Australian Aboriginal instruments and the remainder mostly from the Papua-New Guinea area.

"Unfortunately, very few are ever displayed because the museum does not have the room," says Rosier. "It's a shame because most were obtained in the last century and early this century and there are some beautiful specimens of a type you just don't find today.

"Many are almost priceless.

"An example is an extremely rare instrument called a friction drum which was made only in New Ireland, north of Papua-New Guinea. They are carved from a solid block of wood and played by rubbing with a moistened hand.

"So far as we know, the art of making them has died out.

"Last year I visited most of the major European museum collections of ethnic instruments and altogether saw only 10 of these drums. Yet the National Museum in Melbourne has five of them.

"And all are in storage... the public seldom gets to see them."

"Because, until now, no attempt has been made to comprehensively identify and catalogue collections, Australian museums don't know what all the instruments they have actually are—or the rarity value of some specimens," she says.

The Monash department of music has sent a questionnaire to more than 100 museums, conservatoria, and university music and anthropology departments. It seeks details of any instruments they have.

It also requests any information available about private collections.

To help track down private collectors, news of the survey has also been published in specialist journals.

Rosier points out that collections of both European and ethnic music instruments are well catalogued in many other countries but not in Australia.

"Australia also suffers through not having special facilities for the preservation and display of instruments," she says.

"Many private collectors are keen to put their instruments on display but there is nowhere suitable. Those given to museums in bequests mostly go into storage.
Bandits lose interest in banks

BANK hold-ups are likely to become a less familiar part of the Australian crime scene, predicts a senior lecturer in the Monash Faculty of Law.

The odds are now too loaded against the successful bank robber, he says.

The forecast comes from the initial findings of a research study being carried out by Dr Wickrema Weerasooria, who is in charge of graduate and post-graduate courses in banking law.

He has made his study of Australian bank robberies an optional subject in research assignments for his students and plans a series of articles and a book based on the data collected.

There are at least 10 reasons why bank robbery will not become a "growth industry", says Dr Weerasooria:

- The money that bank robbers get is so little.
- The banks' surveillance cameras are so penetrating.
- Booby traps like "scorpion dye", which are slipped into the loot to explode and permanently mark the robber, are so effective.
- Identification is so easy.
- The risk of getting caught in the act is so great.
- The possibility of panic shooting endangering life is so real.
- Police apprehension and solution rates are so high.
- Convictions are so common.
- Jail sentences are becoming more severe.
- Minimum sentences to be served by bank robbers before being eligible for parole are becoming longer.

Statistics seem to support Dr Weerasooria's prediction. Compared to 65 bank hold-ups in 1975, there were only 10 in the first five months of this year.

The recent "Great Bookie Robbery" in Victoria—the biggest armed robbery in the country's history—netted more loot ($1.4 million) than the total robbed from Australian banks in the last three years.

The $170,000 reward offered for the bookie robbers is more than the money taken in more than 100 of the 453 bank hold-ups in the six-year period 1970-75.

"According to a major trading bank that has been the most frequent robbery victim, hold-ups accounted for only 6.05 per cent of its total losses in 1974 and 15.5 per cent in 1975," says Dr Weerasooria.

"The rest went in cheque frauds, forgeries, negligence in payment and collection of cheques, and embezzlements. The calculations do not take lending losses into account."

He and his students have interviewed bank executives and personnel, members of the Victoria Police Crime Prevention Division and Armed Robbery Division, and prisoners serving terms in Melbourne's Pentridge Jail for armed robbery.

The research reveals that in the 11 years from 1965-75, Australia had 639 bank robberies. In comparison, in 1975 alone there were about 5000 bank robberies in the U.S.A. and about 450 in Canada.

The two banks worst hit were the ANZ (145 times) and the CTB (134). Next in line came the Wæles (97), CBA (88), National (65), State Bank (53) and the CBC (51).

The largest number of robberies was in N.S.W. (164) and in Victoria (148).—

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"These displays could be rotated, say, every six months," she suggests.

"As well, there should be travelling exhibitions visiting country areas. These also could be rotated, spending three or six months in each state.

"Such a system would mean people throughout the country would eventually see a huge variety of instruments, including the thousands that at present nobody sees because they are buried in museum or private storage vaults.

"I'm convinced there would be a rush of people to handle over specimens for public display if we could guarantee proper conditions for their preservation, storage and display.

"There has already been an 85 per cent response to our questionnaire, which is extremely high. And it has produced some fascinating information about private collections in this country.

"One man in Sydney, for example, has nearly 50 player pianos.

"Another, a former coffee grower in New Guinea, has built a house specially designed to display his collection of hundreds of ethnic instruments from PNG and the surrounding islands."

Rosier says the Federal Government should introduce legislation compelling Australians wanting to sell items of cultural value, including musical instruments, to offer them for sale here first before sending them overseas.

"While I was in London I was impressed to see letters from Australians offering instruments for sale there. Some were extremely rare and valuable, such as a particular type of harpsichord of which there are only about 50 in the entire world."

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probably due to the concentration of the major trading bank branches in these two states—followed by Queensland (20), South Australia (19), Western Australia (7) and Tasmania (3).

The two biggest bank robberies were both in Victoria and both from the ANZ bank. In 1974 the bank's Preston branch was robbed of $150,563 (a bank employee being one of the gang) and in August, 1974 the Prahran Market branch was relieved of $107,341.

The average amount taken in a bank hold-up ranged from $2000-3000 while the smallest amount taken was $100 (from an ANZ branch in Sydney in February, 1971).

Few deaths

Relatively few Australian bank officers have been killed in holdups. A manager was murdered in 1867 and another in 1893 (both in Victoria) and two tellers died—one in Victoria in 1924 and one in Sydney last year.

As a general pattern the hold-ups took only a few minutes—more than 10 minutes being considered leisurely: the robbers were normally masked or disguised and the weapons commonly used were pistols, sawn-off shotguns or .22 rifles and, in a few instances, sub-machine guns. The most popular get-away car was a stolen 1964-67 model Holden.

The research also revealed that bank staff rarely received adequate pistol practice and even if they did, were most unlikely to use a pistol in the event of a hold-up. In fact, the Australian Bank Officers Association (ABOA) has urged its members not to use firearms and the banks' own security instructions to employees avoid encouraging a gun battle.

Instead, staff are told to remain calm and be observant during a hold-up, to obey instructions and avoid any action that might incite violence, endeavour to activate a silent alarm, hand over as little cash as possible to satisfy the bandit, and note as many of the hold-up man's characteristics as possible.

"One might query the justification for issuing bank staff with pistols at all if they are reticent about using them," suggests the researchers.

Convicted hold-up men interviewed at Pentridge Jail believed the chance of bank staff retaliating by shooting was remote and the possibility did not deter them.

They also said they only carried firearms themselves "for show" and doubted if they would have used them, even under extreme conditions.

According to a research assignment by some of Dr Weerasooria's students on Victorian bank robberies, the police had solved an "outstanding" 65 per cent of the crimes.

"This is attributable mainly to the work of the Victorian Armed Robbery and Crime Prevention Divisions," it adds.

But these two arms of the Police Force appear to differ on one subject: the number of professional bank robbers the state harbors.

"The Armed Robbery Division are adamant that there are very few—at most only six, some of whom are presently serving sentences," say the Law Faculty team.

"The Crime Prevention Division suggest the number is between 12 and 15, not necessarily always robbing banks but occasionally payrolls, TABs, etc."

Students researchers see the disagreement between the two police teams as a result of an "academic" versus practical viewpoint:

- The Crime Prevention detectives tended to base their concept of "professionalism" on facts and figures, i.e. the number of robberies committed by one person.
- Members of the Armed Robbery Division, who dealt directly with the criminals, had a conception of professionalism which was more character-oriented.

An example of how the two viewpoints could clash was Morris Marion—"Bank Enemy No. 1"—who was the most prolific bank robber in the state's history. He committed 11 robberies in 18 months of 1974 and 1975, yet netted only $38,000.

This was an average of only a little over $3,000 for each robbery.

Persistent

In the Crime Prevention Division's statistical terms he was a professional, but to men in the Armed Robbery Division who dealt with him, Marion was only a persistent amateur.

"Psychological studies reveal that bank robbers who have operated in Victoria have been shown to become progressively more violent with each robbery, as occurred in Marion's case," continues the report.

"One would expect the true professional to become less violent as his expertise increased with experience."

The two police squads do agree that the number of professional bank robbers, the majority of hold-ups are the work of amateurs, desperate for money and invariably primed with large amounts of alcohol or drugs to give them courage.

"An example was a woman who robbed a Melbourne city bank in 1973," says the report. "She had spent the entire previous night drinking vodka as she planned the robbery and actually had difficulty mouthing her demands for money because of her drunken state."

Ironically, police and bank officials would prefer that, if a hold-up has to happen, it is carried out by a professional rather than an amateur criminal.

"The nervous, intoxicated amateur is considered more prone to panic and accidentally shoot someone than a professional who is more aware of the consequences," say the researchers.

Discussions with Pentridge prisoners revealed they had no inherent desire to rob banks only. The tendency was to strike where the pickings were considered easiest. Media emphasis at the time on the undesirability of robbing a certain type of target seemed to play a part in such decisions.

See-through

The report points out that use of bank security devices, particularly television cameras, had become far more widespread since 1973. The cameras can now penetrate the bandit's mask and make identification easy.

Police information suggests that TABs, payrolls, milk bars, service stations and building societies are also acceptable substitutes for a would-be robber deterred from holding up a bank.

There were divergences of opinion between various banks, and between banks and unions covering their staff, about the aims of bank security and the effectiveness of various security devices.

Armed guards as an additional security measure were not favored by Australian banks, says the report. This was on the grounds of cost and also because overseas experience showed a determined robber will first shoot the guard and then demand money or render him helpless by taking a customer hostage.

Hostage-taking, which had become more popular as security devices became more efficient, was now viewed by banks as their greatest unsolved problem.

It was fully appreciated that no security system could combat such a situation without endangering the customer's safety.

Devices tried overseas such as automatically locking doors and audible alarm systems only tended to aggravate the robber into using violence to make an escape. Just recently the banks have agreed to install bullet-resistant screens, which the ABOA has been seeking for some years.

The banks have also increased rewards for information on bank robbery from $2000 to $5000 and are beginning to obtain court orders against convicted bank robbers for restitution and compensation for unrecovered money.
AUSTRALIANS are a nation of nomads. Close to half the population packed their belongings and shifted at least once during a recent five-year period.

The ebb and flow of this vast internal migration—ranging from moves across the street to across the country—has been charted by Monash geographers.

Associate Professor Jim Whitelaw and lecturer Mr. John McKay worked with official data supplied by the Bureau of Census and Statistics. They say the main compulsion behind the mass vagrancy appeared to be the hunt for job opportunities or advancement.

The raw statistics they analysed came from the 1971 Commonwealth Census. This was the first to ask people for details of any change of residence made since the previous Census (in 1966).

The researchers studied moves between the 68 statistical divisions into which the country is divided for Census purposes, as well as moves within individual divisions.

Various types

They also classified movers according to a variety of cross-headings, including age, sex, marital status, occupation, industry, and level of qualifications.

Their basic discovery was that 4.8 million Australians aged more than five years at the time of the Census had changed their place of residence at least once in the preceding five years. This was equal to 44.6 per cent of the over-five population.

And the removal vans were even busier than these figures indicate, because multiple moves during the five years and moves overseas were not recorded.

Within statistical divisions, more females than males had practice in packing their bags, but the males predominated over longer distances.

Moves within statistical divisions accounted for 55 per cent of the great Australian trek, while 45 per cent of the movers—equal to 20 per cent of the country's total population—crossed an SD boundary.

People moving within their own state (793,482) clearly outnumbered those who moved between states (461,661). A significant number (709,550) arrived from overseas, including both migrants and native-born Australians returning home.

But despite the high rates of mobility all over the country, the result in net population gains or losses for individual statistical divisions was quite modest, say the Monash researchers.

Only 23 divisions ended up with more residents, headed by Perth with an increase of 27.5 thousand people. Only four other divisions gained more than 10,000 new residents.

On the debit side there were 45 divisions, but none of them lost more than 10,000 people and most losses were "very minor".

"However, the relatively modest net changes in population as a result of internal migration disguise some very substantial exchanges that took place," the researchers add.

They discovered marked qualitative differences in the age, sex and occupational status of the migration streams and counter-streams.

Migration patterns within state boundaries showed large numbers of young people—especially females—in the 15-24 age group flocking to the capital cities. This was presumably to complete educational and related qualifications and to enter labor markets, the geographers suggest.

They found the effects of this youthful pilgrimage were partly countered by a cavalcade of 20 to 24-year-olds heading away from the "big smoke".

"Presumably this flow includes those who have qualified for the job market and are returning or being posted to non-metropolitan positions," say the Monash researchers.

Migration between states also showed a marked age characteristic, with more than 50 per cent being the result of moves by the 20-44 age group.

The 35 to 39-year-olds in particular showed up strongly, the team discovered. They point out that this period could be considered a critical one in an individual's career history.

As has frequently been recognized in other countries, professional and technical personnel proved considerably more mobile than other employment groups.

But unlike most other countries, when blue collar workers account for the majority of short distance moves, the Australian statistics show white collar workers are more footloose no matter what the distance.

In Victoria, for example, mobility rates for professional and technical workers were double the rates for most other occupations at the intra-state scale and three times the rate for process workers and laborers.

The researchers say there are some weaknesses in the Census data which could only be overcome by collecting more detailed information from different types of large employers and the compilation of worker career histories.

Implications

This next stage of research was currently being undertaken.

If further findings confirmed that job advancement is a potent factor in internal migration, there were some "very direct and immediate" policy implications for the Australian Government, they suggest.

It would contradict a suggestion in the recent Cities Commission report that future policy might be addressed to the country's pool of internal migrants to encourage them to move to future growth centres.

Instead, the researchers suggest, attention should be directed to the composition of productive activities in the post-industrial economy and the direction of policy initiatives toward the goal of encouraging appropriate organisations to establish branches in growth centres.

If this was achieved, the organisations would provide the necessary migrants to stock the new jobs via their own personnel management operations—either by transfer and promotion or by utilising existing skills in recruitment and training.