Medical students, innovation and medical discoveries

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Introduction

Some medical students sometimes regard themselves as an unimportant, unwanted and superfluous member of the medical team, lacking experience and often finding themselves standing in the way, unsure of what to do when a medical emergency arises. However, an examination of medical history reveals that medical students have been instrumental in contributing to new medical developments and discoveries. Their contributions are a reminder of how meticulous study and hard work in clinical and scientific research can lead to significant achievements on a large-scale. A few examples of significant medical student discoveries include the discovery of heparin as a major anticoagulant, identification of insulin in the control of blood glucose and diabetes management, ether anaesthesia and the discovery of the sinoatrial node. With medical schools worldwide and across Australia increasingly incorporating research programmes into medical curricula, medical students' contribution to medical innovation will hopefully continue into the future.

Famous medical student discoveries

Diabetes research

In 1869, Paul Langerhans (1847-1888) a German medical student from the University of Berlin, studying under the famous pathologist Rudolf Virchow (1821-1902), described pancreatic islets in his thesis, and was also the first to discover and describe dendritic (Langerhans) cells in the skin. [1,2] The exocrine pancreas had been significantly investigated since the 16th century and the organ was regarded as a "salivary gland". Langerhans began his research on the microscopic anatomy of the pancreas using pancreatic tissue from humans, rabbits and salamanders. He completed his work within 6 months - the length of a modern day medical school research project - identifying the presence of "irregularly polygonal" cells with clear cytoplasm diffusely scattered throughout the gland. Later, the French histopathologist Edouard Laguesse discovered that the pancreatic islets were in fact a source of internal pancreatic secretion, later determined to be insulin. [1]

Insulin was later discovered by a Canadian medical student, Charles Herbert Best (1899-1978) and a young surgeon, Frederick Grant Banting (1891-1941). As a 22-year old medical student who had just completed his physiology exams, Best was introduced to the 28-year old medical practitioner and surgeon Banting, by his physiology professor, John JR Macleod. [2] Under Macleod's research laboratory and with difficult working conditions, Banting and Best were determined to prove their hypothesis that the factors preventing diabetes mellitus were found in the Islets of Langerhans. These cells could be isolated from a dog, after ligating the pancreatic duct, which caused the exocrine pancreas to atrophy. Banting argued that injecting an Islet extract into a diabetic dog would resolve its symptoms. [1] After much failure, they identified a purified pancreatic extract and tested it by intravenous injection into a diabetic dog. Thus, by late 1921 they were able to show insulin's efficacy in treating canine diabetes. By February 1922 they performed the first human insulin injection to successfully treat Leonard Thompson - a fourteen year-old diabetic who then lived for 13 years (but later died from a motor vehicle accident) with diabetes after initially being expected to live for a few weeks. [2-4] In 1923 Banting and Macleod were awarded with the Nobel Prize and Banting's prize money shared with Best, who was still a medical student at the time.

Anatomy

English medical students of the 18th and 19th centuries had an infamous reputation for bodysnatching from graveyards to provide a sufficient numbers of cadavers for their anatomy dissection studies. [5] The study of anatomy and acquisition of cadaveric material is now very different, but these fanatically enthusiastic early medical student pursuits also paved the way for positive discoveries in the fields of anatomy and surgery. Martin Flack (1882-1931) was an English medical student from Kent, who in 1903 started work at the London Hospital with the famous anatomist Sir Arthur Keith (1866-1955). On returning from a holiday Keith was informed by his excited medical student of a *"wonderful structure he had discovered in the right auricle of the mole."* [6,7] This discovery of the sinoatrial node was made whilst Flack spent his summer holiday dissecting the hearts of moles, mice and frogs with the same surprising results. The structure he had identified resembled the atrioventricular node and thus they concluded that the sinoatrial node was the cardiac pacemaker - the origin of the *"dominating rhythm of the heart."* [8]

The pancreaticobiliary sphincter was also a famous discovery made by a 23-year old Italian medical student from the University of Perugia, Ruggero Oddi (1864-1913). Oddi studied the actions of the sphincter and observed that it controlled the flow of bile from the liver into the duodenum. He was also credited with suggesting that sphincter dysfunction was implicated in biliary tract disease. [1] Other influential student discoveries include William Harvey's observations at the University of Padua that venous valves provided unidirectional blood flow, and the discovery through chick embryos that the heart had an important role in pumping blood via the systemic circulation. [9] Spermatozoa were also similarly discovered by the medical student Johan Hahm (1651-1723) in 1671 after he provided a sample of urethral discharge from a patient with gonorrhoea to the Dutch lensmaker and "father of microscopy" Atoni Van Leeuwenhoek in which he had identified small living "animacules". [1] Leuwenhoek then studied his own semen, identifying the presence of motile animalcules, with blunt round bodies and thin, undulating transparent tails, which he then proposed was involved in fertilising the ovum. [1]

Anticoagulants

Heparin is a major anticoagulant used in modern day medical and surgical practice to prevent and treat thromboembolism. This major pharmacological agent was discovered by a second-year medical student from Johns Hopkins University, Baltimore, Jay McLean (1890-1957). McLean worked in a coagulation laboratory under the guidance of the physiologist William Henry Howell, where he was aiming to investigate procoagulants. In 1961 he isolated a fat-soluble phosphatide anticoagulant in canine liver tissue. [1,10] McLean unfortunately did not further pursue this investigation as he was more interested in procoagulants and he moved to Pennsylvania, so Howell continued research on this anticoagulant. This would later be termed heparin (from Greek, hepar for liver) and by 1937 trials of heparin use had commenced, after which heparin was considered a safe and effective anticoagulant. Unfortunately, however, the discovery of heparin was to become a major area of dispute and a posthumous attempt for a Nobel Prize for McLean later failed. [1]

Ether anaesthesia

While it is argued that the first use of ether anaesthesia for general surgery was by

Table 1. *List of Australian medical schools including those which offer a research component as part of the course. Information gathered from university websites and course guides. Information is current as of 14th March 2012.*

Name of Medical School	Research component included within the degree	Degree duration (years)	Higher research degrees in conjunction with medical degree
Australian National University	Compulsory 1.5 year research project during semester 2 year 1 to end of year 2 in conjunction with other medical studies.	4	
Bond University	One 8 week research placement available during 5th year only for selected students. No other formal research projects.	5	
Deakin University	No formal extended research projects offered with medical studies.	4	
Flinders University	A one year BSc (Hons) project is available to selected students for research.	4	
Griffith University	No formal extended research projects offered with medical studies.	4	
James Cook University	Option for medical students to undertake two years of research in parallel with year 5 and 6 with the award of MBBS (Hons), or to undertake an additional year between years 3-4 or years 4-5 as a full time BMedSci Honours research project.	6	
Monash University	No research as part of medical degree, but option to undertake one additional research year with a BMedSc (Hons) project prior to starting clinical attachments.	5	
University of Adelaide	All students are required to complete a research proposal project in year 4. There is also an option to undertake a one year B.Med.Sc (Hons) project for further research.	6	
University of Melbourne	One semester of research in year 3 and in year 4 as the "Scholarly Selective" courses, with compulsory annual student conferences in years 1-4.	4	Medical course was converted to an MD degree in 2011, with an increased research focus.
University of Newcastle	No formal extended research projects available, but there is option of undertaking an additional BMedSci Honours year of research at least after completing 3rd year of BMed.	5	
University of New England	No formal extended research projects available, but there is option of undertaking an additional BMedSci Honours year of research at least after completing 3rd year of medical studies.	5	
University of New South Wales	Compulsory one year Individual Learning Project (ILP) during years 3 or 4, or a BSc (Med) Hons year during year 4. There is also a medical lateral entry scheme after successful completion of a medical science degree, followed by a BSc (Med) Hons year prior to entry into 4th year medicine.	6	
University of Notre Dame	Honours Research Project available for selected 4th year students in conjunction with their final year.	4	
University of Queensland	A one semester Honours research project is offered during 3rd year.	4	
University of Sydney	An optional 6-12 month research project is offered as part of the MBBS (Hons) project and can be completed within the 4 year course.	4	Plans are in progress to convert the MBBS to the MD degree.
University of Tasmania	Students have an option of completing an extra Research Honours year as part of the MBBS (Honours).	5	
University of Western Australia	Compulsory one year Research and Discovery project undertaken in 4th year . A combined BMedSc degree is also offered in conjunction with MBBS for extended research. This combined degree is completed over 6 years, the research component is conducted part-time and longitudinally over 3 years.	6	From 2014 the MBBS degree will be converted to the MD degree.
University of Western Sydney	Optional one year honours stream research project is available apart from compulsory medical studies.	5	
University of Wollongong	No formal extended research projects offered with medical studies.	4	
Total offering research projects	5 with compulsory research programmes. 14 with additional optional research projects including an additional Bachelor of Medical Science Honours degree. 3 medical schools do not offer formal research projects as part of their course.		

William Crawford Williamson Long (1815-1878), the first recorded administration of ether anaesthesia for dental surgery was performed by a medical student named William E. Clarke in New York, 1842, in which Clarke was assisting a dentist to perform a painless tooth extraction. [11] Long was a young country doctor who is credited to have administered ether to a young man in 1842 for which a painless neck cyst removal was performed. [1]

Infectious diseases

Even as a first year medical student, Sir James Paget was contributing to significant discoveries. Although he is well-renowned for the eponymous conditions of Paget's disease of bone (osteitis deformans) and Paget's disease of the breast and nipple, his name was published as a first-year medical student for discovering the nematode *Trichinella spiralis* in human muscle, the cause of trichinosis. [12] Similarly, an Argentinian medical student, Alejandro Posadas discovered Coccidioidomycosis in 1892, describing a case report of an Argentinian soldier with cutaneous manifestations of the disease. Later, in 1926 a second medical student, Charles Smith inadvertently contracted the disease by inhaling the spores whilst working on the organism in the laboratory. He later developed pleuritic chest pain and purulent productive cough - which helped identify the clinical presentation of the disease and luckily he survived to tirelessly study the disease throughout his professional career. [13]

This list of historical medical student discovery is by no means exhaustive. However, it highlights the influence of medical students on medical research and innovation throughout history. Although current freedom of research may be limited by modern day bureaucracy, students still have chances to contribute to research, through increased university research opportunities.

The role of medical schools and research

The modern day medical student may question what is left for them to discover, as modern medicine becomes increasingly sub-specialised. The explosion in medical advances over the last few decades makes it daunting to even make a small contribution. A quick internet search may reveal that many ideas have been exhaustively investigated and recent discoveries are only possible in certain areas such as molecular biology. [1] However, with the availability of recent technologies, modern research methods and laboratory techniques, students still have many options available to unleash their creativity and pursue their interests through research. Additionally, mandatory and optional research components have increasingly become part of medical school training programmes, which provide numerous opportunities for students to become involved in working with world-expert researchers, academics and clinicians.

Of the nineteen Australian medical schools, five have a compulsory medical research project as part of the medical school's training program (see Table 1) and fourteen have either short optional research project placements or allow for an additional Bachelor of Medical Science Honours year in conjunction with the medical degree. The number of Australian medical schools offering research projects as part of their course highlights the significance of medical research for current graduates. The trend for incorporation of research programs in medical schools has also contributed to the recent development of a shift by some universities from the standard Australian MB BS towards Masters level MD degrees recognising research. [14] Although this would be a positive step towards increasing medical student research and innovation, it poses many new challenges and risks creating a two-tiered system with a divided medical profession. [15,16]

The AMSJ continues to promote student research by facilitating publication of medical student ideas and research findings. In addition to assisting publication of student research, the third volume of the journal continues to strive in its aims (see above) of celebrating medical student success in other areas. [17] The AMSJ has now extended to become a truly nation-wide peer-reviewed journal, with our current student staff representing eleven Australian medical schools.

Australian Medical Journal Aims

- To provide a medium for Australian medical students to publish their work and share ideas with their peers.
- To provide a suitable forum for students to make the transition between assignment-writing and producing publishable academic work.
- To inform students about medical topics and issues not typically addressed in core curricula.
- To facilitate discussion of current issues relevant to medical students.
- To allow Australian medical schools to showcase the research aspects of their programs.
- To provide a further incentive for students to produce high-quality work in their studies.
- To foster the next generation of Australian medical researchers and physician-scientists.
- To provide an avenue for students interested in a career in medical editing or publishing to pursue this interest as a student staff member.

Conclusions

There are many opportunities available for Australian medical students to become involved in research with leading researchers, academics and clinicians. Medical students have the opportunity to contribute to ground-breaking cancer research, assist in drug trials, help with the identification of disease biomarkers and pathogenesis of complex diseases, or determine the efficacy of new surgical techniques, to name a few examples. Even if research degrees or projects are not offered by some universities, medical students should consider becoming involved in extra-curricular research in addition to their busy schedules to fuel their intellectual intrigue, assist in continuing medical and professional development and increase their general knowledge. This will help to continue the tradition of innovation, ultimately leading to further significant medical student discoveries. We hope that the AMSJ will provide an avenue for medical students to contribute achievement in innovation, with fresh ideas and novel findings in the years to come.

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