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Providing Research Opportunities for Medical Students: Challenges and Opportunities

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Abstract
Research electives are very popular components within the undergraduate medical degree program at University College Cork, with all students required to complete an original translational or clinical research project in their final year. Barriers to the provision of undergraduate research opportunities include costs of laboratory-based and clinical projects, staffing resources, complex and lengthy research governance procedures, and increasing student numbers. In this article, we describe the undergraduate research program at our institution, and outline several initiatives designed to counteract the impact of these challenges.

Introduction
In medical schools throughout Europe, fostering an understanding of scientific method and provision of research opportunities are core elements of undergraduate medical education. Medical schools in countries like Ireland, Germany, and the UK are increasingly expecting undergraduates to complete research projects, usually as part of their student selected components (SSC) programme.[1-4] Completion of short research projects is also a common feature in medical curricula in the USA.[5] The World Federation of Medical Education (WFME) has highlighted the importance of scientific method as among the basic standards for medical education; they propose awarding a quality standard to those curricula which encourage and prepare students to engage in medical research and development.[6] The UK General Medical Council recognizes that new medical graduates should be able to apply scientific method in their execution and appraisal of medical research, while the British Medical Association has outlined the importance of research and training to the future development of the health service in the UK.[7,8]

Positive student outcomes attributable to participation in research at an undergraduate level include improved performance across a number of evidence-based medicine (EBM) - linked assessments (e.g. formulating research questions, quantitative data analysis, critical appraisal of scientific/medical literature).[9,10] Further outcomes include increased recruitment into academic medicine, enhanced employability, and improved postgraduate research participation and productivity.[11,12] There is also emergent evidence to link increased undergraduate research exposure with improved clinical decision-making and patient care.[13] These tangible benefits are reflected in student attitudes and perceptions, as surveys show that students value opportunities for conducting research, seeing research experience as a means to establish professional credibility, gain skills, improve their undergraduate curriculum vitae, and confirm future career plans.[3,14] In any environment where there is intense competition for postgraduate training posts (particularly in competitive specialties such as surgery), undergraduate research experience, especially if evidenced through peer-reviewed publications, becomes an important commodity.[1,3,15] Several authors have however raised questions concerning the value of undergraduate research activity. They propose that many basic science or clinically-based student research projects are of little novelty or scientific impact, can over-burden institutional governance processes and, in the case of clinical research, may place human participants at greater risk due to the research inexperience of the student investigator.[16,17] Our experiences over five years of the challenges and opportunities in our institution

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in providing research opportunities for medical students are likely to be representative of those encountered elsewhere, and of interest to colleagues.

Undergraduate Research Projects in Medicine – our Cork Experience

The research strategy of the College of Medicine and Health (incorporating the Schools of Dentistry, Medicine, Nursing, Pharmacy, Occupational Therapy, and Speech and Language Therapy) at University College Cork has a basic science, clinical, and public health focus, which is supported by the university's network of hospitals and associated research centers and institutes. The School of Medicine at UCC has developed a substantial expertise in professional learning and behavior in the form of a research-active academic Medical Education Unit. University College Cork (UCC) offers three undergraduate programs in medicine: a 5 year direct entry [DE] program for Irish and EU school leavers (with a small number of places available to mature students; ~ 120 students per year intake); a 4 year graduate entry [GE] program for graduates predominantly from Ireland and North America which commenced in 2008 and currently accepts ~ 80 students per year; a twinning program with the Allianz College of Medical Sciences in Malaysia (~ 60 students per year). One of the exit outcomes in our undergraduate medical program is that students demonstrate evidence of successful application of scientific process and methodology to the collection and analysis of research data. To this end, students are required to complete a senior research project in the final years [years 4-5 for DE, years 3-4 for GE students], which constitutes 10% of their final year aggregate score [see figure 1 for project timelines]. There is flexibility in the type of research deemed acceptable which can range from a laboratory-based to a clinical or translation project, and all such projects are assessed via completion of a minor dissertation of the research project, and oral presentation of the research findings to an open forum. We believe that the research project completed in the senior years functions as a capstone module, allowing students an opportunity to integrate EBM skills and knowledge gained in compulsory or elective courses throughout the curriculum. Additionally, students are allowed to complete research-based elective modules during the preceding years as part of our student selected components [SSC] program. The role for SSCs within the core undergraduate medical curriculum has been reviewed elsewhere, but their purpose generally is to extend the depth of study, support EBM, enhance professionalism and personal skills and encourage effective communication.[18,19] Our experience is that students who are very career aware and have made decisions regarding their long-term career strategies are most likely to pursue a research-based SSC in the early years of the course before the senior research project.[4]

The Senior Research Project Process

As indicated in Figure 1, students commence their senior project work in year 4 [DE] / year 3 [GE]. All students are given seventeen months to complete their short project dissertation, from initial approach of supervisor to completed written report. All students are informed from the outset that they are expected to initiate, plan and organize their own research projects. They are required to initiate contact with a research supervisor in their chosen area of research. While some universities have encouraged students to integrate with existing ongoing projects in their departments of interest, we have encouraged students to approach supervisors with specific research questions, rather than expect the supervisor to suggest research topics.[1,20,21] We suggest that the process of acquainting themselves with their prospective supervisor's current research interests is important in their development as researchers, reinforcing the self-directed nature of seeking research opportunities, and fostering an appreciation of research collaboration. Students are also instructed that if they become embedded with an existing research group, it is important that they play an independent role in the project and contribute intellectually to the conception and design of the study. This is also emphasized in the assessment process. With respect to research type, original research and audit-style projects are acceptable, with completion of a systematic review accepted in exceptional circumstances (e.g. where the suggested supervisor has a particular expertise in this methodology).

The School of Medicine maintains an active research website, which students are encouraged to visit from first year onwards. Aiming to ensure that students are aware of ongoing research programs at UCC, this website contains information about research-related events and opportunities, research governance procedures, and undergraduate funding opportunities. A number of events are organized each year to specifically showcase institutional research to our undergraduate medical students. All staff and students receive a monthly newsletter advertising both staff and student research successes. In their penultimate year, all students complete a two-week preparatory lecture module. This is composed primarily of didactic lectures and

practical skills workshops. As EBM is a central focus throughout our medical curriculum, this essentially acts as a revision course, providing an opportunity for students to revise and elaborate upon practical EBM skills. As part of the module assessment, they are also required to devise and present a project proposal to school examiners, constituting a concise summary of the research question, main hypothesis, and justification of the planned methodology. Typically, students require little guidance in their choice of research area, as their future career motivates them in their selection of project area.[3,4]

All project proposals are subject to full ethical review. Further information regarding the research governance process is detailed below.

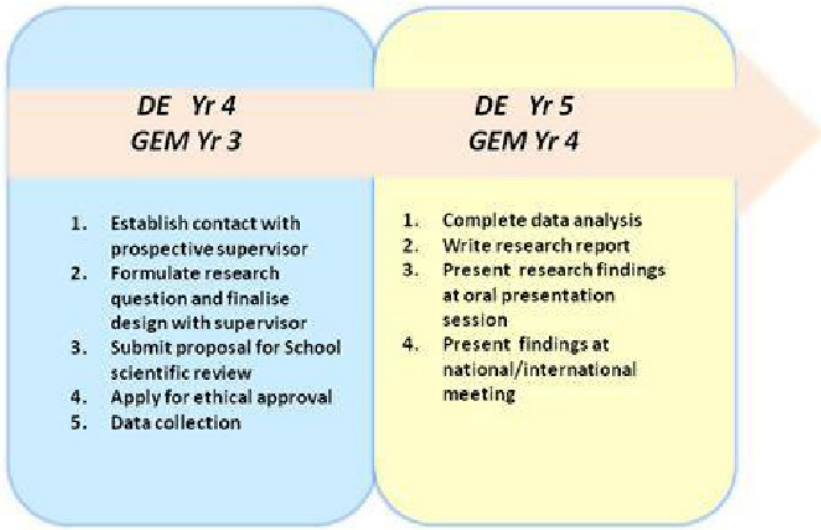

Figure 1: *The senior undergraduate research project process at UCC*

UCC Senior Undergraduate Project in Medicine - Trends and Figures from 2008 - Present

Students have undertaken a wide variety of senior research projects related to medicine and health. Figures 2 & 3 provide a summary of percentage of projects (total n = 498) completed in various areas of medicine (and other clinical and biomedical sciences) during the years 2008-2012 inclusive. As indicated in Figure 3B, the majority of research projects were quantitatively based, and the cross-sectional design was the most frequently employed clinical study design [Figure 3C]. We have found that few students select the systematic review option due to a perception that other study types are more likely to result in generation of publication-suitable data. With respect to study design, there is an increasing trend towards selection of laboratory-based experimental studies in the area of applied biomedical sciences (see figure 2).

A preliminary comparison of research project marks [comprising aggregate of presentation and dissertation scores] indicated significant group differences between DE and GE students in the year 2011-2012 [t (150) = 2.55, p = 0.01], with students with a prior degree scoring higher than their undergraduate-entry counterparts. This is not surprising, as previous research from our School has demonstrated that GE students are more likely to avail of research opportunities during their medical education.[3,4]

The Senior Undergraduate Research Project – Student Perspectives

At the outset of the project planning process, student concerns typically focus on degree of novelty of their research projects, possibility of delayed progress due to research governance procedures, and some uncertainty regarding what study criteria increase likelihood of publication in peer-reviewed journals. In many cases, we find that students feel that their research projects will not contribute significantly to the body of scientific knowledge. Some of the barriers to effective student participation in the project process include some questioning of the relevance of the endeavor, as some students feel that it represents an academically-centered activity which is distant from the main focus of their professional education.

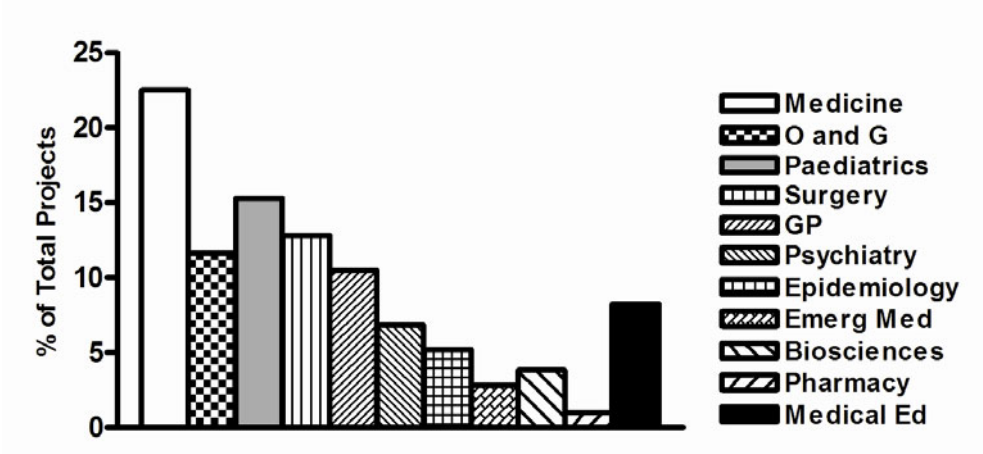

Figure 2: *Number of projects completed, calculated as a percentage of total (n= 498), across the following departments/areas during 2008-2012: medicine (including projects in cardiology, dermatology, endocrinology, gastroenterology, general medicine, geriatrics, haematology, immunology, infectious diseases, medical oncology, nephrology, neurology, neurophysiology, ophthalmology, palliative medicine, radiology, respiratory medicine, and rheumatology), obstetrics and gynaecology (O & G), paediatrics, surgery, general practice (GP), psychiatry, epidemiology and public health, emergency medicine (Emerg Med), biosciences, pharmacy, medical education (Medical Ed).*

Although students generally find the research process arduous, they enjoy the journey as well as the opportunity to contribute to knowledge in their research area.[2,9] Both research evidence and anecdotal observations from our institution would support this interpretation.[3] Table 1 outlines a student research case study example, including a short account of the research process from the student perspective.

UCC Undergraduate Research in Medicine: Opportunities and Challenges

The experience in our school has been that a number of factors converge to present challenges and barriers to the provision of undergraduate research opportunities in medicine. Like many schools elsewhere we have increased our student intake across both DE and GE programs at UCC, we operate in an environment where there are fewer undergraduate research funding schemes, staff teaching and administrative load has increased, and there is an increasing trend towards introduction of stricter research governance procedures. However, we have developed several initiatives designed to counteract the impact of these challenges as follows:

1. Streamlining the Internal Research Governance Process

It is generally recognized that developing an understanding of research ethics and the workings of ethical review bodies is an important aspect of developing skills in clinical reasoning and judgment, as well as the development of professional ethical behaviour.[22]Teaching students how to construct research protocols that ensure scientifically valid findings while safeguarding participants or experimental subjects is also recognized as integral.[23,24]

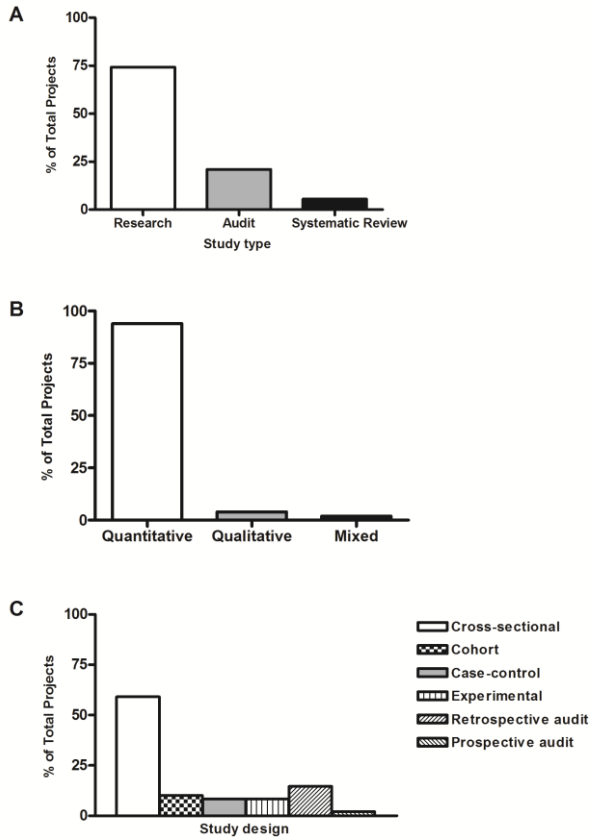

Figure 3*: Percentage of total number of senior undergraduate research projects completed during 2008-2012, summarised according to study type (A), methodology (B), and study design (C).*

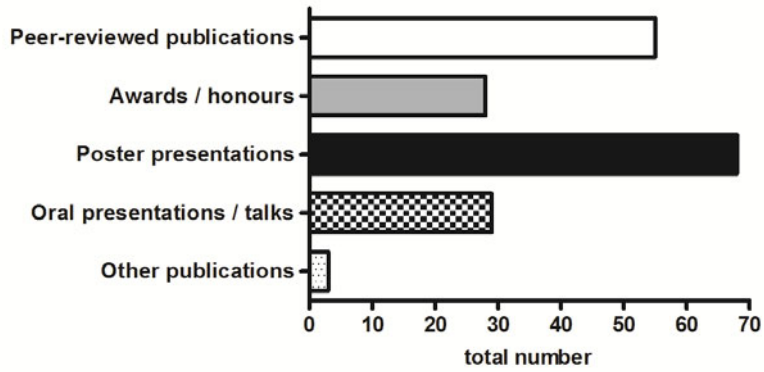

Figure 4: *Summary of the dissemination status of student research projects published during the period September 2008 – November 2012.*

The burden of research governance, including application to ethical committee across universities and healthcare institutions, is increasing to the point that completion of the research project during the time allotted within the curriculum is becoming increasingly difficult.[2,25] This also influences medical students' perceptions of engagement in research, as they identify that securing ethical approval can prove a major obstacle.[24] However, governance remains crucial, as these observations are taking place against a backdrop of ongoing concerns about the potential conflict of interest (in addition to potential for scientific misconduct) arising from allowing students to gain course credits for successful completion of clinical (or indeed preclinical) research projects.[17] Five separate approaches have been proposed towards ethical oversight of student research: (a) a lenient approach, in recognition of the prioritization within student research projects of learning outcomes, as opposed to research outcomes; (b) a separate "specialized" governance process, due to the conflict of interest noted above; (c) application of stricter governance processes to student projects due to the increased risk status of human or non-human participants; (d) excluding the possibility of student research projects as a result of the myriad of ethical and logistical challenges; (e) application of same scientific and ethical review process towards students projects as those conducted by experience researchers.[17]

This latter approach has been adopted in our School. We feel that student projects should be subject to the same institutional review processes, that they encourage students to apply a more rigorous and careful approach to study design, as well as increasing the possibility of producing publication-worthy research data. All student research projects (including clinical audit and applied biomedical research) are subject to institutional ethical review. We operate a no-exceptions policy, both to ensure that students acquire familiarity with clinical and research governance frameworks, and to reduce the potential for confusion on the part of supervisors in deciding which projects which may/not require ethical approval, as this has been an issue elsewhere.[26]

Students are required to submit a project proposal at an early state of the process (see figure 1), prior to preparation of the ethical application, which is subject to a rapid internal scientific review step by academic staff within the School of Medicine. Where a study is deemed to contain significant methodological flaws or may present potential practical obstacles, or where the student's specific contribution to the project is unclear, major or minor revision is advised. Congruent with procedures employed by many medical schools, we have adopted a governance approach which is proportionate to the risks that the majority of these projects generate. While it is important to emphasize that student projects are not subject to lower ethical standards, the process is tiered, reflecting degree of risk associated with the proposed project. In common with many institutions, the majority of survey-based studies, audits, and chart reviews are subject to expedited approval. Those with greater risk liability are subject to full ethical review. Where students are participating in projects which have already been approved by the ethical review body, a revision to the existing approved protocol is submitted involving addition of student names to the project. In the past we have found that one of the primary reasons for increased administrative burden on the clinical research ethics committee is the necessity for resubmission of incomplete ethics documentation, resulting in many applications

being evaluated on multiple occasions.[27] Reasons for return of applications to the applicant have included absence of consent forms, insufficient study background, and absence of investigator signatures. For this reason, we have introduced a procedure whereby students are required to submit their ethics documentation to the School of Medicine, whereupon applications are checked for accuracy and completeness. All ethics applications are then sent directly to Clinical Research Ethics Committee of the Cork teaching hospitals (CREC) for review.

High-profile press revelations regarding violations of patient confidentiality has led some undergraduate medical programs to modify their research project module, allow students to generate a project protocol and complete a sham "research governance process", without collection of data.[2] We contend that this practice of a "dummy run" at research does not provide a full experience of the opportunities and pitfalls associated with research. We have sought to ensure that, while acknowledging the challenges of student research projects (i.e. deadlines, place in curriculum, administrative delays), this does not involve compromising existing scientific and ethical standards and that a successful undergraduate research program should seek a balance between both priorities.

2. Space in the Curriculum

It has been noted in the literature that one of the obstacles many medical schools encounter regarding integration of research projects within the undergraduate program is finding space in the curriculum. In order to reduce the potential waste of opportunity arising for poor-quality student research employing patients or non-clinical human participants, we have sought to integrate the development of EBM and research skills from the beginning of the degree program, recognizing that inculcation of research knowledge and fostering of specific skills (e.g. data manipulation and analysis, conducting a literature review etc.) at an early stage will raise the quality of the senior research projects.[28] Our students find that the prospect of a high stakes senior research project makes such teaching more relevant to them and embeds the EBM curriculum in the course.[3]

Dr. Stephen Power graduated in medicine from UCC in 2011, having studied medicine via the GE route. He completed his senior undergraduate project within the Department of Medicine under the supervision of Professor Mary Horgan, Consultant Physician in Infectious Diseases at University College Cork. The title of his project was "Challenges in chronic disease management of HIV infection**:** A study of predictors of medication non-compliance and assessment of long-term drug toxicities in a treated population". He has since presented this work at both national and international conferences.

"The final year project is often considered a rather unwelcome, time-consuming and arduous task especially in the face of the many other responsibilities which final year begets. However, despite these criticisms, ultimately, I found the experience to be a really rewarding one. Of all the elements of final year, it is the only aspect which is directed and dictated by the student. Like them or not, medicine, surgery, obstetrics and gynaecology and paediatrics are not optional components of the curriculum. In contrast, the Final Year Project allows you to personally decide on an area or topic that particularly interests you and to become more actively involved in this field.... Any final year project is constrained by specific limitations; namely that only a certain amount of time can be devoted to the task and secondly, that it is generally a solo effort without the back-up of a more extensive team which the more seasoned researcher might have at their disposal. Therefore, designing a project that is feasible and achievable within the context of the fourth/final year schedule can be one of the most problematic steps of the entire process. Assessing all of the challenges in the management of HIV was unrealistic, no matter how big your research group or budget. Therefore, my project concentrated on two small areas of the puzzle.... Having concluded my final year project, I believe that while opinions amongst students regarding the endeavour will, no doubt, remain mixed, it certainly gives undergraduates a flavour for research and the associated opportunities and pitfalls. In addition, the chance to become actively involved in research in an area of your interest at an undergraduate level (albeit a small involvement!) is an opportunity that will be valuable when competing for positions in the same field at postgraduate level. Although the hours spent sifting through thick patients' files or extracting data from large databases is, admittedly, exasperating and laborious at times, the personal satisfaction of developing your own, individual idea and creating a small piece of novel information makes the endeavour unquestionably worthwhile."

***Table 1**: Undergraduate research in medicine – a student's perspective*

Competing clinical exposure requirements across the senior cycle of the undergraduate medical curriculum mean that very little course time can be dedicated to the project dissertation. Students are required to balance the time and effort between their project and other assessments which contribute to their degree score. We have overcome this challenge by adopting a longitudinal approach. The importance of the senior research project is emphasized from the outset, students are research enabled as the course progresses and undergo a two week preparatory course described earlier. Finally, students are given an extended period of time [17 months] to design and complete their research study. The curriculum contact time (excluding meetings with a supervisor) required to specifically support a senior research project is limited. The extended project timeline relieves pressure on students to generate project results quickly, and increases the attractiveness of project supervision from the supervisor's perspective.

3. Issues related to Capacity

As student numbers increase, there is an accompanying pressure to identify projects and supervisors. One solution we have successfully explored is to widen the scope of potential project areas by encouraging interdisciplinary research opportunities, as well as supervision of students by academic staff from other clinical sciences (e.g. pharmacy, nursing etc.). The GMC has emphasized the importance that medical schools provide formal curricular interdisciplinary learning opportunities to today's undergraduate medical students.[7] In a broader context, the benefits of interdisciplinary practice across a variety of healthcare contexts are well documented, with poor relations between physicians and allied health professionals contributing to reduced patient satisfaction and poorer overall treatment outcomes.[29] In our school, as part of a multinational EU-funded project, BioApp [http://www.bioapp.eu], we have established a biomedical design research module which combines undergraduate medical/engineering students at the senior undergraduate level in interdisciplinary research projects, wherein they design novel biomedical device and employ engineering expertise in the resolution of healthcare problems. Opportunities for similar novel collaborations will vary but are available in each institution and often help to foster innovative research themes.

4. Focus on Research Outputs

We rely on original peer-reviewed publications and conference abstracts as evidence that students are successfully disseminating research findings. While not factored into course assessment, students are encouraged and incentivized to prepare their work for peer-reviewed publication, to compete for research awards such as summer undergraduate research scholarships available from national scientific research funding bodies and selected charitable organizations, and to present results at national/international research meetings. Faculty within the medical education unit are required to function as a resource to support students in this regard. Additionally, internal funding is provided, on a competitive basis, for students who wish to present their research findings at national and international scientific meetings; these funding awards are capped and generally do not fully cover all expenses associated with attending a conference. Priority is given to students who have been invited to present their work orally, as well as to those who have applied previously (successfully or otherwise) to external funding bodies for funds to support their research activity. Figure 4 provides a summary of the dissemination status of student research projects published during the period September 2008 – November 2012. Monitoring of outputs can be challenging as many of these projects are subsequently prepared for publication in the months and years following graduation, especially as students begin to apply for postgraduate training positions. Therefore, it is likely that outputs are underestimated. It is important however to document successes to ensure continued support for the effort invested. Establishing a framework in which successful staff-student collaborations are regularly advertised, even in internal newsletters, further incentivizes others to disseminate their work in a peer-reviewed arena.

5. Securing Buy-in from Research-active Clinicians and Basic Science Staff

The onus is on medical schools to foster a 'win-win' attitude to undergraduate research participation, where students benefit in a number of ways (complete course requirement, gain research experience and outputs, explore career areas), as well as clinicians and academic faculty mentors (active research program, completion of service audits, publications and other outputs). Addressing reluctance of some staff members to include students who are time-limited in terms of their commitment to a project, and who may have specific training needs, is a key challenge in ensuring that the students are mentored by a motivated group of supervisors.[5] Some authors have

suggested that academic schools/departments should provide staff training opportunities in student supervision, as well as other means of faculty support.[3,30]

Particularly in the case of laboratory-based projects, research staff may be wary about allowing relatively inexperienced students gain access to expensive equipment, and may feel that this same lack of experience may result in less efficient use of laboratory consumables.

However, at a time where wider economic issues have resulted in contraction of research funding opportunities across the biomedical sciences, medical students can assist many research staff to complete studies or to generate pilot data in the absence of alternative funding for research students. We have also found that, in cases where research supervisors have explicitly requested a student with a specific skill-set or range of techniques, the resultant "matchmaking" exercise has meant that the research supervisor values the time invested in the project, while the student benefits from the supervisor's enthusiastic engagement in the project. This has proven particularly useful in the case of GE students, many of whom have already completed biomedical research projects as part of their first university degree. Additionally, in recognition of the burden of completion of research governance procedures, we support students during their two-week teaching block as they complete the necessary documentation, and provide follow-up support where necessary. This support minimizes the administrative burden, freeing up supervisors to assist the student with project design and logistical arrangements, through to manuscript write-up, addressing reviewer concerns etc. In order to encourage clinicians who do not have a substantive academic appointment to undertake supervision of student research, special consideration is given to such participation in the awarding of honorary titles or any adjunct promotion pathways. Furthermore such staff-student collaborations are advertised as a route to promote postgraduate student recruitment.

Conclusion

Undergraduate medical student research is promoted by all accrediting bodies. Students are also keen to avail of both laboratory-based and clinical research opportunities but are aware of the challenges involved, as indeed are research supervisors.

Our experience of enabling student research and requiring research output as a learning outcome of our course has required us to explore solutions to the common institutional hurdles and identify solutions to allow us to embed the activity in the curriculum, support and encourage our students, streamline student research governance and secure supervisor engagement. We hope that our experiences may help and encourage others.

Key Words

Medical students, research projects, research governance, research outputs

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