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ORIGINAL PAPER

Does conventional early life academic excellence predict later life scientific discovery? An assessment of the lives of great medical innovators

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Summary

Background: Perhaps, as never before, we need innovators. With our growing population numbers, and with increasing pressures on our education systems, are we in danger of becoming more rigid and formulaic and increasingly inhibiting innovation? When young can we predict who will become the great innovators? For example, in medicine, who will change clinical practice?
Aims: We therefore determined to assess whether the current academic excellence approach to medical school entrance would have captured previous great innovators in medicine, assuming that they should all have well fulfilled current entrance requirements.
Methods: The authors assembled a list of 100 great medical innovators which was then approved, rejected or added to by a jury of 12 MD fellows of the Royal Society of Canada. Two reviewers, who had taken both the past and present Medical College Admission Test as part of North American medical school entrance requirements, independently assessed each innovator's early life educational history in order to predict the innovator's likely success at medical school entry, assuming excellence in all entrance requirements.
Results: Thirty-one percent of the great medical innovators possessed no medical degree and 24% would likely be denied entry to medical school by today's standards (e.g. had a history of poor performance, failure, dropout or expulsion) with only 24% being guaranteed entry. Even if excellence in only one topic was required, the figure would only rise to 41% certain of medical school entry.
Conclusion: These data show that today's medical school entry standards would have barred many great innovators and raise questions about whether we are losing medical innovators as a consequence. Our findings have important implications for promoting flexibility and innovation for medical education, and for promoting an environment for innovation in general.

Introduction

In many disciplines, there is great competition for training positions that is usually based on academic excellence[1,2] and possibly including involvement in specific types of extracurricular activities. However, whether success in meeting entrance criteria for academic or professional programs relates to later life achievements is rarely assessed.[3]

We have, therefore, documented the early lives of 100 great medical innovators whose ideas have changed the practice of medicine over the last 300 years since the age of the Enlightenment.[4–6] Our aim was to determine whether current medical school entry criteria, had they been applied throughout history, would have allowed entry to medical school for all great medical innovators.

Methods

Initial innovator selection

The principal investigator and three co-investigators made a tentative list of 100 medical innovators who were associated with significant discoveries, made over the last 300 years that have influenced the practice of modern medicine (D.J.A.J., V.J., E.V. and V.C.). This list was further added to and refined after input by three advisors with academic medical backgrounds. The number 100 was selected because the outcomes could be expressed directly in percentage terms.

For innovator list oversight

This list of 100 medical innovators was then assessed by a jury of 12 MD scientists.

Jury selection

The study description was first published in the Bulletin of the Royal Society of Canada before the recruitment of jurors. The jury was then selected at random from all those current fellows of the Royal Society of Canada who were also medically qualified (MD) ($n = 92$). Random selection was achieved by ascribing each fellow a number such that a new random group of 10 fellows could be generated repeatedly. Emails were then sent to groups of 10 fellows selected at random from the list of 92. Emails to those potential jurors again outlined the objectives of the project and requested confirmation of interest within a 2-week period. After confirmation of interest, fellows were accepted as jurors. This process was repeated until 12 positive responses were obtained. Those 12 positive responders became the jurors who were then sent the tentative list of 100 medical innovators to review.

The protocol was approved by the Ethics Committee of the University of Toronto (RIS Human Protocol Number: 29483).

Innovator list oversight

Jurors were asked to add to the list those innovators they felt should be included, but were not on the list, and to subtract an equal number of those on the list whom they considered of lesser merit to maintain the total number of nominations at 100. Unlike conventional juries, the jurors had no contact with each other. Jurors were given a month to make their additions and deletions and return their list to the principal investigator (D.J.A.J.). A majority of votes in favor (≥7/12) determined addition of a new innovator's name to the list and a majority of votes against determined deletion of an existing name. Since subsequent assessments failed to identify the early life educational history of 14 innovators, replacements were taken from those names proposed as innovators by the Jury based on the number of votes they had received, even though none reached the predetermined inclusion criterion of 7/12 votes (the maximum number of votes obtained for an innovator was 4/12).

Assessment of early education of innovators

Relevant data on educational achievements of each innovator prior to and during their secondary school and early university career or post-secondary school training were extracted from the literature by two independent reviewers from a team of three (V.H.J., E.V. and V.L.C.). All these reviewers had taken both the pre- and post-2015 Medical College Admission Test (MCAT) exams as preparation for medical school entry. Those innovators whose early life academic careers provided evidence that might have limited their acceptance to medical school were given special attention and were further assessed independently by at least two groups of two assessors (four to six additional assessors) to ensure that failure to gain medical school entry was indeed likely.

Early education search strategy

Data on early education prior to and during medical school, or the equivalent period for those who did not attend a medical school, were obtained by literature searches from biographical material including: Encyclopedia Britannica, the Nobel Laureates web site, Google searches, Wikipedia, biographies and autobiographies. Innovators were excluded where no entries were found, and they were replaced by additional innovators, identified by the jurors, who had received the greatest number of juror votes.

Extractors looked for features that might favor or detract from the likelihood of medical school acceptance such as scholarships, prizes and graduate degrees or near failures, failures, general lack of interest in academic subjects, dropouts or disruptive behavior. Since attention is focused on standardized testing in physics, chemistry, biology, biochemistry and understanding of technical or literary passages and more recently biochemistry and the behavioral and social sciences (e.g. MCAT in North America, etc.), serious attention was also paid to assess how well innovators were likely to perform in exams related to these topics. For this assessment, each innovator was given a score for each of the 7 MCAT topics, where 2 was excellent, 1 was adequate and 0 was given if the innovator had evidence of not having studied the topic, poor performance or failure (Table 1). No score was given if there was no documentation. An overall score of 2 guaranteed medical school entry, 1 was a pass but no guarantee and those with score of 0 were considered to be unlikely candidates for medical school entry. A zero score was given to any innovator who had failed single exams, medical school entrance exams or interviews, had documented evidence of being a poor or disinterested student, had dropped out of an academic program, shown disruptive behavior or failed to have taken basic science topics, as these characteristics were seen as not favoring current medical school entry requirements (for details of ascribing the overall score please see Table 1). Where general comments such as 'excellent student' were not linked to a specific topic, they did not alter the overall scores given. Disagreement on the score for a given innovator was settled by the consensus of the reviewers and if consensus was not possible, the majority decision was taken after an independent assessment by a third reviewer.

Statistics

The 100 innovators were given scores of 0–2 based on the criteria in Table 1. The assumption was that all great innovators would score 2 (certain medical school acceptance) and none should score 0 (medical school rejection) and whether the 95% confidence intervals were significantly different from 0%. Furthermore, the hypothetical situation of the success rate was also determined if excellence was restricted to 1, 2, 3, 4, 5, 6 or 7 MCAT topics to determine whether innovators may benefit from a narrower focus of interest. In this scenario, failure to take an essential topic, dropout or failure overall or in individual topics were not counted against the medical school acceptance of the innovator.

Results

Overall grade for pre-2015 medical college admission test

Of the 100 great innovators that were graded (Supplementary Tables S2 and S3), 73 had MD degrees (2 had MD and PhD degrees), 27 were not MDs (21 had PhDs, 1 MSc and 1 BA [counted as an MA]) and 4 had no record of university degrees (Supplementary Table S5; innovator specific references).

On the assumption that all great medical innovators would gain medical school entrance, 100% of the innovators would be expected to be in the overall #2, certain admission category. Only 24 innovators (24%, 95% CI 16.0–33.6%) were in this category, a number significantly different from the expected 100% ($P < 0.001$) (Figure 1). Similarly, no great medical innovator would be expected to be in the 0 category (likely denied medical school entry). However, a significant number were in this category (24%, 95% CI 16.0–33.6%) ($P < 0.001$) (Figure 1).

Reasons for zero scores for 24 of the great innovators included: no basic sciences ($n = 10$), no chemistry ($n = 3$), no biology ($n = 8$), drop outs ($n = 4$), expulsion from the equivalent of high school or university ($n = 2$) and failed medical school entrance exams, or important single or final exams, or had been overall borderline failures ($n = 8$) (Table 2).

Single-subject excellence

Might great innovators have specific interests and so benefit from fewer subjects? If only excellence in one of the seven exam subjects (physics, chemistry, biology, biochemistry, verbal reasoning, psychology or sociology) were required, then 41% (95% CI 31.5–51%, $P = 0.104$) would be accepted, dropping to 23% (95% CI 15–32%, $P = 0.029$) for two topics; 14% (95% CI 8–23%, $P < 0.001$) for three topics, 8% (95% CI 4–15%, $P < 0.001$) for four topics, 2% (95% CI 0.2–7%, $P < 0.001$) for five topics and 0% for six and seven topics (Figure 2).

Table 1. Criteria for classifying medical school acceptance based on MCAT

Acceptance classification	Score	Evaluation criteria
Certain ('excellent')	2	i. A major prize, scholarship or award and recognition of major distinction (excellence)[a] in one or more MCAT subjects (prize, near top of class or better etc.) ii. Excellence[a] (near top of class) in all the three basic MCAT subjects: physics/chemistry, biology, verbal reasoning (+psychology/sociology and biochemistry currently) iii. A scholarship to medical school or Phi Beta Kappa (assumed excellence in all MCAT subjects) Pre-med PhD = 'excellence' for one MCAT subject (the PhD discipline)[a]
Possible ('adequate')	1	i. Adequate in the three MCAT subjects, no failures and no distinction ii. Medical school entry, but unremarkable, providing there are some pre-med school education data iii. Said to be excellent in one or two subjects but no prizes, scholarships class ranking etc. (a 'good student') iv. (iv) If started MD after 1928 and no other information to clearly indicate score
Unlikely ('poor performance')	0	i. Overall failure, borderline failure or any exam failure prior to entering medical school ii. One or more rejections of medical school application iii. Any drop out, from pre-med or medical school iv. Failure to take one or more of the basic MCAT subjects by the time that medical school entry would normally be applied for (e.g. during or immediately post first undergraduate degree in Canada and the USA and immediately post-secondary school in Britain, Europe and Australia) Originally physics/chemistry, biology, and verbal reasoning were our focus but we have also assessed innovators on the basis of more recently included topics (psychology/sociology and biochemistry currently). If detailed description of pre-MCAT educational history information was available, but no mention of a specific subject (e.g. biology or chemistry), then assumed subject not taken (e.g. if comprehensive information is given for education but no indication of courses taken in ≥1 domain, then assumed course not taken)
Unknown		(i) Insufficient early life (pre-med school) data to determine aptitude or lack of it or no confidence in data (e.g. conflicting reports)

[a]Innovators must meet at least one criterion within the evaluation criteria, for a given score, to be given a specific classification.

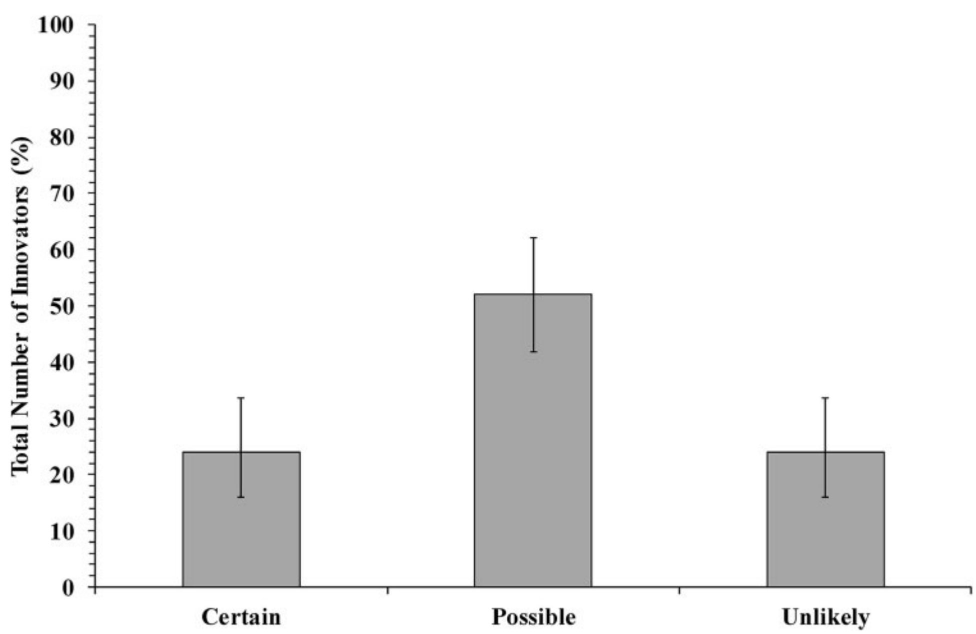

Figure 1. Comparison of numbers of innovators within the acceptability categories (with 95% CI).

Table 2. Reasons why 24% of medical innovators were judged, unlikely medical school entrants

Name	Date born	Discovery	Reason for classification	Comments
Paul C. Lauterbur	1929	MRI (1971–73)	No biological sciences	Graduated as engineer. Took graduate courses while working for Dow Corning Corporation
James Lind	1716	Scurvy	No basic sciences	Apprenticed to a surgeon and then joined Royal Navy as ships surgeon. Awarded MD later by Edinburgh
Peter Mansfield	1933	MRI	No biological sciences	Failed II+ exam. Left school at 15 to become a printer's assistant, job at the ministry of supply at the Rocket Propulsion Department. Later studied 'A' levels in the evening to gain London University entrance, BSc first class Physics, Queen Mary College and PhD physics majored in physics (NMR University of Illinois)
Brenda Milner	1918	Recognized multiple memory symptoms and founder of field of neuropsychology	No biological sciences or chemistry but had neuropsychology	Studied mathematics, physics and then neuropsychology at Girton College Cambridge
William T.G. Morton	1819	Ether anesthetic	No examination passed in basic science, dropped out of high school (financial reasons), dental school and Harvard Medical School, in that order	No evidence of serious studies, although he persisted at dentistry for some time but never qualified
William Osler	1849	Medical education for the modern practice of medicine	No systematic study of basic sciences but informally attended medical subject lectures. He appears to have been expelled from his college. and then went on to study medicine	Received a scholarship in first year for algebra, trigonometry, Greek, Latin, Roman History and the classics. Played practical jokes that got him expelled
Louis Pasteur	1812	Germ theory, pasteurization	No biology of note. Standard mathematics, physics and chemistry. Failed final exams at the Royal College Besancon. Failed entrance exam to École Normale Paris	He was driven, serious, a royalist and devout Catholic, enjoyed fishing and sketching
Percivall Pott	1714	Chemical carcinogenesis scrotal cancer in chimney sweeps	No basic sciences, apprenticed to a surgeon barber	Trained to enter the church
Michael Smith	1932	Self-directed mutagenesis	No biological science	Studied chemistry at Manchester. State scholarships for graduate studies
Wilhelm Conrad Röntgen	1845	X-rays	Failed entrance exam to University of Utrecht? No chemistry or biology	Studied mathematics and mechanical engineering at Polytech school in Zurich—but focused on physics and laboratory work
Hans Selye	1907	Biology of stress	Borderline failure. Barely passed exams in high school (College of Benedictine Monks. Hated biology)	Educated by Governess and private school before Med school at the German University of Prague
Ignaz P. Semmelweis	1818	Cleanliness to combat puerperal sepsis	No basic sciences. Studied law at Vienna then after first year switched to medicine	No clear reason why he switched to medicine. He followed the philosophy curriculum at school and his father thought that he should have a career in law and accounting
Santiago Ramón y Cajal	1852	Neuroanatomy, cortical mapping, neuroconduction	Borderline failure, poor student. Barely passed exams, if at all. Expelled from school,	Graduated medical school (MD, Medical University of Zaragoza). He thinks because his father

Table 2. (continued)

Name	Date born	Discovery	Reason for classification	Comments
			apprenticed to a shoe maker and barber for a time, returned to school, still a poor student, but accepted for medical school at Zaragoza due to paternal influence (his father taught anatomy there)	taught anatomy there (influence)
George Constantin Cotzias	1918	L-DOPA treatment of Parkinson's	Rejected applications at six U.S. medical schools due to lack of basic biochemistry, pharmacology and physiology	Was later accepted at Harvard for MD to complete medical training, due to a sympathetic entrance interviewer
Frederick Grant Banting	1891	Insulin	Failed first year divinity at the University of Toronto. Petitioned to do medicine	An average student but serious and studious. Had an enquiring mind
Claude Bernard	1813	Father of experimental physiology	Lack of basic scientific training	By 21, he was an amateur physiologist and an Apothecary's assistant who went to Paris and studied medicine at the Hôtel-Dieu de Paris where he was an intern
Denis Parsons Burkitt	1911	Viral cause of a lymphoma-Epstein–Barr virus. Role of dietary fiber in disease	Borderline failure at engineering school so dropped out and transferred to medicine at Trinity College, Dublin. Had great difficulty with basic science entrance exams (especially chemistry)	Although in first year engineering, he joined a religious group (group 40) that gave him a sense of direction and resulted in his desire to do something useful, so he changed from engineering to medicine
James Cook	1728	Fruit and scurvy, explorer	No basic science training	Left schooling early, apprenticed to a cobbler. Ran away to become a merchant sailor on a coal vessel and transferred to the navy. Studied navigation in his spare time. Rose rapidly through the ranks
Charles Darwin	1809	Evolution and evolutionary biology	No evidence of basic science training. Dropped out of the Medical School of Edinburgh to study divinity at Trinity, Cambridge	At Trinity, he was not allowed to take the honors degree but did well in the 'ordinary degree', final (10th in his class) due to coaching by an etymology professor who befriended him due to his interest in beetles and who provided him the opportunity to go on the Beagle to the Galapagos
Austin Bradford Hill	1897	Smoking and lung cancer, biostatistics	No basic science training. At school studied English, Latin, Greek and mathematics and could not do laboratory work at university due to TB complications. Therefore, he took a BSc in economics	At school, prior to TB, was a sportsman and not a scholar
Godfrey N. Hounsfield	1919	CAT scanner	No training in biology or chemistry. Attended Faraday House Electrical Engineering College, London	At school only interested in physics and mathematics. Inability to master other disciplines. Prevented him from attending a University
John Hunter	1728	Advocate of scientific method in medicine	No training in the basic sciences. Assisted his brother in dissections at his School of Anatomy and Surgery. Later after discontinuing courses at Oxford, studied medicine at St.	William Hunter, his eldest brother, a successful gynecologist and anatomist, provided support and advice to John who also spent time as a Military Surgeon before becoming faculty at St.

Table 2. (continued)

Name	Date born	Discovery	Reason for classification	Comments
			Bartholomew's Hospital under Percivall Pott	George's Hospital and later training physicians such as Edward Jenner
Francis Crick	1916	DNA	No biology training. Good at mathematics and physics (won prizes) but poor at chemistry	BSc in physics and then graduate work on viscosity of water at high temperature at University College, London
Allan Macleod Cormack	1924	CAT scans	No biology training. Good at physics and mathematics at school	Did engineering at Cape Town but switched to do physics (BSc), and then graduate work on crystallography (MSc)

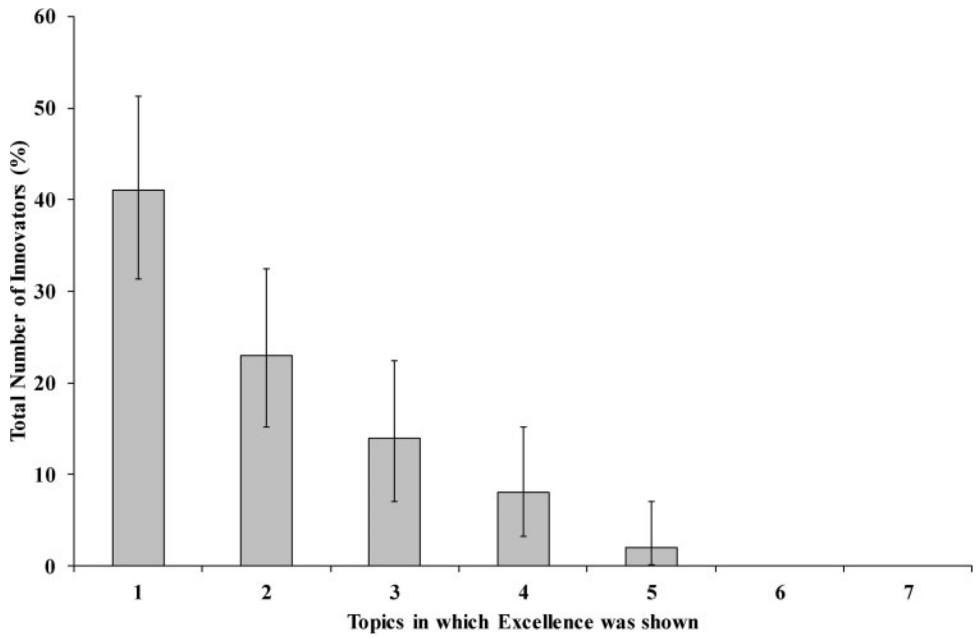

Figure 2. The effect on the acceptance rates when excellence in more than one topic is required (number of innovators demonstrating excellence and 95% CI).

More recent medical innovators

To assess if the changing academic culture over time related to preparedness for Medical College Admission exams, we assessed the proportion of those born after 1930 and thus likely to be applying to medical school in the era when preparation for the basic sciences was more ubiquitous (∼1950 onwards). For the certain and possible medical school entrants, the rates for those born after 1930 as a proportion of their whole post 1950-era group was 28% (5/18) (95% CI 19.3–37.7%) for the 'certain', and 56% (10/18) (95% CI 45.3–65.5%), for the possible, and not significantly different from the whole group percentages. For the unlikely group, there were fewer outright failures at 17% (3/15) (95% CI 10.0–25.5%) but again not significantly different from the group as a whole.

Discussion

These data indicate that many of the lives of the great medical innovators have not followed a straightforward path that would have guaranteed medical school entry based on current criteria. Many would currently be considered unsuitable for medical school entry,[7] eight of our 'unlikely' innovators had no basic science training and indeed nearly one-third of them were not medically qualified.

The current data raise the general question of the essentiality of prerequisites for admission to specific programs and how rigid these should be. In the case of medicine, the Flexner report of 1910 that focused on the essentiality of the basic sciences, physics, chemistry and biology, was hailed as a major advance.[8] Yet the majority of our 'unlikely' innovators lacked either chemistry or biology or all three basic sciences, physics, chemistry and biology. In addition, the recent additions to MCAT of psychology and sociology would disqualify the majority of past innovators from medical school entrance. The argument is made that knowledge of these new topics is 'basic' for the successful education of physicians.[1,2,8–10] But the same argument could equally be made for inclusion of nutrition, exercise physiology and the science and implications of climate change, etc.[11] Such prerequisites might also help to prepare the practicing physician.[1,2,8–10] However, our medical innovator data suggest 'less is more' in terms of the number of subjects in which excellence is required. Thus, the 'capture rate' of medical innovators, with excellence in one MCAT topic alone was greatest, at 41%, but going down to 2% when excellence was required in five or more topics.

What detailed knowledge of physics was required by Werner Forssmann in 1929 to perform the first cardiac catheterization? What did Jenner know of immunology, let alone the related physics and chemistry that allowed him to introduce vaccination for smallpox that eliminated this very serious viral disease, an achievement that has not been repeated despite a post-Flexner population of well-educated physicians? Howard Florey was a physiologist who then changed fields and became a professor of pathology but his microbiological discovery of the treatment of bacterial disease with a penicillin mold is what he is remembered for.

There is also an impression that all great medical innovators should be dedicated serious hard workers, happy to learn as directed by their teachers. William Osler was expelled from college for playing practical jokes, Ramón y Cajal was expelled from high school, William Morton of anesthesia fame dropped out before finishing first dental and then medical school. Hans Selye reportedly hated high school, Charles Darwin disliked mathematics and was not allowed to do the honors degree at Cambridge, and Austin Bradford Hill was a sportsman not a scholar prior to contracting TB. Furthermore, some innovators (such as Louis Pasteur, Conrad Röntgen, Frederick Banting, Hans Selye, Ramón y Cajal and Denis Burkitt) were 'failures' or borderline failures at school, college or university. Others, such as George Cotzias, had applications to medical school rejected on multiple consecutive occasions.

In fact so close was Denis Burkitt to failing his basic science entrance exams to Trinity College Dublin, where he ultimately studied medicine, that he would define himself as 'Irish by birth and Trinity by the Grace of God'.[12] The medical historian, Michael Bliss commented that Frederick Banting would not be accepted into medical school today as a failed first year divinity student who simply petitioned to be transferred to medical school (without examination)[4] (please see Supplementary Table S5 for innovators specific references for all the above).

The argument can be made that with the superior educational opportunities available currently, all great medical innovators would have excelled such that medical school acceptance would be guaranteed. This argument, however, still does not answer the question of the necessity for high achievement in all traditional prerequisites as essential for training in any field.

The weaknesses of our study are many but are largely unavoidable. Many of the great innovators never took standardized basic science medical school entrance exams or their equivalent. Ascribed scores are based on what was recorded of their early life's educational experiences, incomplete as they often are. However, we did have the unique advantage that our three assessors had taken both the 'old' and 'new' MCAT exams and were familiar with the preparation required for success. We selected 100 great medical innovators. It was not relevant whether they were the top 100, although that was our aim. Even if those chosen were not the precise top 100, they are all individuals whose medically related contributions can be considered, at the very least, to be of high quality and with significant impact. They have been judged worthy by a jury who have medical degrees and have also all made significant contributions to their respective fields.

However, we also acknowledge that for every one on this list there are or were several other men and women who but for the mischance of time and place of birth, adverse life events, perverse decisions made by others, sickness and wars, would also have been candidates for consideration. This fact highlights the importance of chance and good fortune in any successful undertaking.

Also by our emphasis on great innovators, we have failed to acknowledge the significance of teams and teamwork and the enormous importance of the mentors who opened doors and the teachers who counseled wisely, examined fairly and helped to create the environment that promoted innovation.

The strength of this report is that it is the first attempt of which we know to link early life educational success to major later life innovations, in this case in medicine.

Ideas for the future

We may help present-day innovators to identify themselves by giving precedence to those who have completed research projects in the final school years before applying to university, by intercalating BSc, MSc and PhD programs within the medical curriculum. Offering options to transfer second- or third-year high flying biochemists into clinical medicine with appropriate accommodations and also those from other disciplines such as microbiology, nutrition, kinesiology, psychology, environmental science together with students from liberal arts disciplines who may, after an accelerated preclinical program, make a significant contribution to innovation in medicine. Finally, persistence is a quality shared by many great innovators so space should be made for the persistent even if not the brightest. After graduation, we need to support graduate research programs to allow promising graduates to follow a research science career, both basic and clinical. Finally, the all-important chance encounter should be encouraged by involving students with visiting professor programs, funding student electives and conference attendance and presentations, with sufficient time to involve their colleagues and learn how to enjoy collaborative research.

Conclusion

We conclude that the current prerequisite approach may be satisfactory for the selection of those with adequate learning skills to cope with current methods of teaching, but it may not be ideal as part of the process for the selection of great innovators, though we recognize it was not designed for that purpose. The diversity of their interests suggests that more flexibility is required, both in the admission process and in their subsequent education, to suit the diverse interests and backgrounds of great innovators.

Supplementary material

Supplementary material is available at *QJMED* online.

Author contribution statement

Substantial contributions to the conception or design of the work, or the acquisition, analysis or interpretation of data - DJAJ, VHJ, VLC, EV, CWCK, KS, AM, CNB, TMSC, PG, RBH, MDH, AML, SAN, TWP, BIP, ARR, MV, YTW, LC, RJDS, SN, SCP, CG, TT, JLS. Drafting the work or revising it critically for important intellectual content - DJAJ, VHJ, VLC, EV, CWCK, KS, AM, CNB, TMSC, PG, RBH, MDH, AML, SAN, TWP, BIP, ARR, MV, YTW, LC, RJDS, SN, SCP, CG, TT, JLS. Final approval of the version published-DJAJ, VHJ, VLC, EV, CWCK, KS, AM, CNB, TMSC, PG, RBH, MDH, AML, SAN, TWP, BIP, ARR, MV, YTW, LC, RJDS, SN, SCP, CG, TT, JLS. Agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved - DJAJ, VHJ, VLC, EV, CWCK, KS, AM, CNB, TMSC, PG, RBH, MDH, AML, SAN, TWP, BIP, ARR, MV, YTW, LC, RJDS, SN, SCP, CG, TT, JLS.

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Data sharing

Detailed study data are available in the Supplement. We have no additional data available, but we are happy to discuss the ranking of specific individuals, since these conclusions involved consensus amongst the assessors.

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Conflict of interest. D.J.A.J., teaches and has selected potential medical students at the University of Toronto. He was not good at the basic sciences, specifically physics. He is grateful to Dr. Dennis Parsons, as the medical tutor at Merton College, Oxford, for accepting him to read Medicine, on the understanding that he would teach him concepts, recognizing his deficiency in mathematics. He has therefore always questioned what is basic. J.L.S., teaches medical students and is a curriculum lead in the MD program at the University of Toronto. He has been frustrated by the difficulty his most innovative research students have had in entering medical school and his most innovative medical students have had in pursuing research. He has received research funding, in-kind research support, travel funding, honoraria and/or speaker fees from a broad range of food companies, healthcare companies, agricultural trade groups, non-governmental organizations, and/or governmental agencies, none of which pertain to medical school admissions or undergraduate medical education. The other authors have no conflicts of interest to disclose.

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