Commentary

How can we Improve Clinical Research in Clinical Practice with Better Research Outcome?

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Abstract

This paper explains some of the difficulties doctors face when taking up a career in research. It describes the efforts by the government and the Ministry of Health (MOH) to nurture the Clinician Scientist Programme. The nature of research and the mindset of clinicians who are passionate about research are explored and the reasons which drive some of them to pursue a research career. It discusses the need to have structured training for research and how continuing research education is necessary for the researcher. The paper discusses the goals for research and how we can achieve better research outcomes and the importance of good mentorship. It suggests ways to engage more doctors in research in the restructured hospitals by overcoming some of the problems they encounter. Finally, it relates the Biomedical Science initiative of the government through the National Research Foundation and the various programmes in Translational Clinical Research available for clinicians who are keen on a research career.

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Introduction

The bulk of this paper is taken from one of the two keynote addresses delivered on 30th November 2010 at the recent Festschrift of our Mentor, Professor Judith Whitworth, who was until recently, the Director of John Curtin School of Medical Research in Canberra, Australia.[1] John Curtin School was the first school for medical research in Australia. Prof Whitworth was someone who had received many honours, among which were the Howard Florey Professorship, Australian of the Year Award, Chairperson of the Australian National Medical Research Council, Consultant for WHO Medical Research Advisory Committee.[1] Prof Whitworth had trained three heads of department in Renal Medicine from Singapore, Prof Evan Lee from National University Hospital and Prof Woo Keng Thye and Prof Wong Kok Seng, both from Singapore General Hospital.

We presented our views on translational research and how we went about it in Singapore. The other main speakers were the chairpersons from Australia and the United Kingdom and at the general discussion, all agreed that the sad thing about research was that clinicians interested in research were not given protected time or the financial support. Clinician researchers were not compensated for remuneration lost for doing less clinical procedures when they switched to doing more research work, hence there were few takers and many countries are faced with a dearth of good clinician researchers and clinician scientists. At the meeting, the consensus was that only mandates from government coupled with financial support would make the climate conducive for medical researchers.

In this commentary, we would like to discuss some issues and deliver several key messages concerning the practice of clinical research by doctors in the restructured hospitals and how we can improve the present situation. Whilst we recognise the importance of clinical research as a means and a goal to pursue new and better treatment of diseases for patients through the discovery of new drugs and new therapies, we have to find ways to encourage more doctors to engage in research as Clinician Scientists (CS) and Clinician Researchers (CR). We have to examine and explore the

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mindset of doctors who are driven to research. What is it that makes them pursue a life of research despite some of their difficulties encountered? And the third question facing us is how to improve the situation within the restructured hospitals where there are not many doctors doing clinical research. What can be done to improve the situation?

The Nature of Research and What Drives Doctors to Do Research?

Research Minded Doctors

It has always been our belief that you can bring a horse to water, but you cannot force him to drink if he is not thirsty. Whilst we speak about growing the number of clinician scientists, we must remember that this is a rare breed and the bulk of the research output is in fact produced by doctors who are not clinician scientists, but ordinary doctors who engage in research because they are driven to do research for various reasons, among which passion is one of the main driving forces. These doctors will still be engaged in research even though they are not paid specifically for it. And some of them can be very passionate about research and many consider research to be a part of good doctoring, whether it is in bench research or in clinical trials.

For those who spend about 20% to 30% of their time on research, they should be correctly labeled Clinician Researchers (CR). Over the past 8 years or so, many hospitals have been giving such doctors an extra year end bonus based on their productivity in terms of peer review papers or even the number of research grants they can attract to themselves. But rewards for research work is far from the minds of such individuals. One of their incentives is that they can present their research work at overseas conferences and perhaps enjoy a working holiday where they can also discuss their work with their peers overseas. The institutions would also fund these doctors for travel, accommodation and even provide them with per diem allowance. For the more senior doctors, they are usually invited by the overseas organisers with all expenses paid, some even receiving honorarium.

But beyond all these perks and incentives of publishing papers and attending conferences, the truth about doctors who participate in research is that for many of them, doing research is a very large part of their practice of medicine; simply put, research is the answer to the need to solve clinical problems or find cures to their patients' maladies and seek answers or solutions to these clinical problems. We call this altruism. Basically it is to endeavour to find answers to questions concerning disease causation, processes or pathogenesis and cures and in many instances, as in the case of epidemics or pandemics like bubonic plaque or H1N1 influenza, to immunise and remove the threats of a disease, the way it had been done for smallpox or poliomyelitis. Very rarely does a doctor seek a cure or remedy to a disease so that he could gain from it financially. Such a thought would have been furthest from the mind of the medical researcher. It is our fervent belief that a doctor in answer to his calling dons the mantle of the saint rather than the shopkeeper who sells cures to his patients. Some doctors may pursue research as part of their ambition. A successful researcher should have an edge over his peers when it comes to promotion as he is considered more academic and has additional credentials in terms of his research contribution which sets him apart from his peers.

The seeds from which we grow research are important. We must recruit doctors who are research minded. These would be doctors who are gifted with research imagination so that they can ask the Research Question in order to formulate the Research Hypothesis. These doctors must already possess a wealth of clinical experience to have had encountered various types of research problems to enable then to ask research questions. These same doctors are also the ones who would have recognised an urgent need to solve clinical problems in order to improve the care of their patients. This is what would have spurred them to submit research grant applications or engage in drug trials to seek answers to their patients' problems. Throughout the history of medicine, this has always been so. Medical history is replete with the great discoveries of clinician researchers through the ages. Names like Semmelweis, Paul Erhlich, Fleming, Hunter, Willis, William Harvey and countless others, surgeons and physicians who have braved the challenging research trails, some suffering ignominy and eventual madness like Semelweis because they were ostracised by their colleagues who were blind to the clinical evidence presented by these great men, who were thinkers way ahead of the doctors of their times. Even giants like Lister and Pasteur had to face great and almost insurmountable difficulties before their life saving medical discoveries were accepted by the medical fraternity.[2]

Now that we are professing to be Academic Medical Centres or AMCs, the departments and institutions should recruit and retain doctors who are research minded so that they can in time contribute to our research excellence.

The Spirit of Research

Researchers require the right mindset, to persevere despite disappointments. They must possess a "never give up attitude", knowing full well that it is about 99% perspiration and less that 1% inspiration. Research is hard work and a discipline with little return. It is passion which drives the researcher. It can be compared to someone entering a Holy Order with the vow of Celibacy. You can imagine the faces

of the audience in the assembly as we voiced those words during our talk and many of them were heads of research back home. We believe they all knew what we were talking about, because they all looked serious except for a few cryptic smiles, including that of our Mentor. We think they all understood that researchers have to be tough minded to withstand loneliness and privation. So who in his right mind would want to do research? Obviously, the candidates for research cannot be too bright. And yet ironically, from every cohort, it is always from among the brighter ones that we tap our research talents.

Goals of Research

We always maintain three tenets in this respect. The first is to pursue the dream, like don Quixote, the man from la Mancha.[3] Who does not have a dream? If we do not dream, we die. We stop dying only when we start to dream.

The second is to search for the answer to our research question. Often, the answer is not forthcoming because we have not phrased the question appropriately. There is no right or wrong question, only what is appropriate to the experiment we devise. Hence, the hypothesis and the methodology will be the determinants of our success. Famous words often attribute success to serendipity. Only a fool would lay claim to such. There must have been much gut feeling, early morning awakening and working of the subconscious or superconscious mind or what some call the "inner game" before Archimedes shouted Eureka as the water was displaced from his bathtub.

The third goal of research is to define the truth. In research, we search and we hunger for the truth. This is what sustains us, and after we have gone a long way, casting our inner eyes and our thoughts backwards, we sometimes see what we had missed as we backtrack. This is because we have done due diligence and finally, after turning all the stones, we found the answer glaring at us, glistening on the pavement amongst the dry leaves and broken twigs. It is the truth which shines through, the truth which we ferreted through our hard work.

The Truth in Research

You see things differently, not on the surface as what others see because you know what you are looking for. You do it with an open mind, without prejudice with an "empty mind". You must be calm, collected and objective and you must be able to recognise it. What others do not see, you pursue relentlessly, believing in yourself despite what others tell you, despite "evidence-based".

You develop it, grow and groom it. This is your first rough diamond. You spend sleepless nights agonising over it. Meanwhile you keep polishing it with your own sweat, tears and blood, only to discover that it's a fake and the dazzle fizzles off and you are disappointed.

But once in 10, 20 or even 30 attempts, you find a rough gem which you polish and it gleams. The more you polish, the more you challenge it, the more shining it becomes. This is the lustre of Truth shining through. It dazzles you and your whole team. This is Eureka.

How can we Achieve Better Research Outcome?

Better Research Outcome

A sound hypothesis is mandatory. This is the first prerequisite which any grant agency or funding body will scrutinise when considering the viability of a research proposal. Next, the design of the study, especially if we are doing a clinical trial, should be correct or appropriate. We should spend more time to think and craft a good design. The study must be adequately powered, taking into consideration the type of statistical analyses involved. The statistics may be significant, but if the study is underpowered, the study has no merit. Methodology is another important area of concern. A flawed or incorrect methodology will produce spurious or erroneous results which would invalidate the study. The method must also be reproducible. All the necessary steps should be documented so that an independent group can repeat one's experiments and be able to obtain the desired outcome. After the initial success, one should run repeated tests again and again to validate and confirm the reliability of the data.

A researcher is someone who seeks the truth. Sometimes, the truth is not so evident like a rough diamond which may initially appear like a lump of coal. It is only with repeated polishing that we can detect the glimmer. Keep polishing until the truth eventually shines through. With repeated testing and increasing the number of subjects, the statistical significance should be more obvious. If the data is not correct or true, then the statistical significance will disappear to one's chagrin.

We must always be the first to challenge our own hypothesis before others get to it. Compare one's work with that of others. Always perform diligent literature search. Cross check, validate and get an independent audit of the work if necessary.

Training in Research

Training of doctors in order to equip them with research skills and techniques is important. Just as we have to keep abreast with the latest in clinical medicine, especially with our own particular subspecialty so that we can continue to be licensed to practise in that specialty, the same should

also be true for research. There should be no such entity as self taught or half baked research. Researchers, like doctors should be accredited. We remember, many years ago, we were trained to do research in immunology. When, the new area of molecular biology was introduced, we had to attend workshops and courses to equip ourselves with the technique and the knowhow. And to be involved in animal work, one had to attend courses and workshops in experimental surgery. In 2000, when genomic research was introduced, we together with our scientists had to learn the ABCs of genomics before we could become versed in doing genomic research. We had to learn the tools of the trade through workshops and apprenticeship. It is like writing poetry. You must know the style, form, syntax and rhythm. So one has to go to school for creative writing, attend workshops and seminars.

Research is like this. One needs to be equipped with the necessary mental, spiritual and technical skills for research. It is therefore not unreasonable to suggest that one would have to enroll in a research school and attend classes in research in order to become a researcher.

Good Clinicians Make Good Researchers

A doctor keen in research must have practised in a particular specialty and become one of the better ones in the field. He must have a broad experience and have encountered much experience in problem solving. He must also possess a certain level of good clinical skills in his field. In this way, there will be a good birthing for research within such a medical mind.

In addition, the doctor engaged in medical research must also participate in Continuing Research Education (CRE) as much as he is involved in Continuing Medical Education (CME) to maintain his annual practicing certificate.

The world is constantly evolving, so is research. It evolves and spins ceaselessly around the whole universe of the Research Galaxy. Keep up with the times, learn new techniques in order to stay relevant.

A Good Research Mentor

Having a good Mentor is important. Our first research Mentor was Professor Chan Soh Har.[4] In 1976, our old boss Dr Lim Cheng Hong gave us 6 months protected time in research so that we could be attached to the WHO Immunology Research Lab at McAlister Road. We spent 6 months hands-on intensive training in research and did our first lab research project on the effect of uremic serum on lymphocytes using phytohemagglutinin assay which we presented at the Singapore Malaysia Congress of Medicine.[4] We also wrote the paper together with Prof Chan's help. It was our first research paper and it was published in the Congress Proceedings.[4] Both Dr Lim and Prof Chan helped to launch our research career. The project was supported by a research grant of $1000 from the Medical Clinical Research Committee, which in addition to granting certificates for the conduct of clinical drug trials in those days, also had a kitty of $100,000 to support medical research for small grants from $1000 to about $3000 a year. This was in the early 1970s, long before we had the Department of Clinical Research and the National Medical Research Council.

In 1978, we were away at the Royal Melbourne Hospital on a Colombo Plan Fellowship for hands-on training in Nephrology with Professor Priscilla Kincaid Smith. Our immediate supervisor was Professor Judith Whitworth who was also our Research Mentor.[1] During our one year in Melbourne, we completed three projects and learnt much from Judy. You stay with her in the ward, clinic or research lab or clinical trial, watch and learn through her example. She sets great store through accountability and one has to work diligently and report to her. She would go through the data with a fine toothed comb and it could be a very painful process, but one will learn lessons one will never forget. Her axioms are, "Publish in haste and repent at leisure."; "Once in print, cannot change or retract."

How can we Improve the Situation in Restructured Hospitals?

To achieve this, we have to build a pool of Clinician Scientists (CS). But this is easier said than done. In Singapore, today we have about 80 CS and we took about 5 to 6 years to produce just this number. Over the next 5 years, we hope to double this number. In 2003, the National Medical Research Council (NMRC), together with Biomedical Medical Research Council (BMRC), launched the CS programme where we funded about 6 CS.[5] With the introduction of the Graduate Medical School, namely, the Duke- National University of Singapore (NUS) Graduate Medical School (GMS), it is hoped that about half the graduating cohort will become CS.

As doctors, many of us engage in medical research, in varying degrees, depending on our own interest and the amount of time we can spend, since we all have many other commitments. Some are more committed to research compared to others, but on the whole, the time the average doctor would spend in research could vary from about 5% to 30% of his time. Those who enroll in the CS programme would spend up to 70% to 80% of their time in research.

A practicing clinician can engage in two or more roles. For most doctors, the main role is that of a practicing clinician and one or two other roles, more commonly in teaching as a Clinical Teacher or as Medical Researcher with or without

protected time in research. Most doctors in institutional practice would shoulder a clinical as well as a teaching workload, less in research. With the present climate where there is a greater need to have clinical teachers, especially with the Residency Programme recently introduced, more doctors are now engaged in teaching, like in Duke-NUS GMS where those engaged in teaching are remunerated in addition to their clinical component. With this added incentive, it is also justified to expect good quality and dedicated teaching from the teachers hired under an adjunct scheme.

However for research, apart from the CS programme where the recipients of the CS award are salaried with protected time for research, with the present system, they are guaranteed only their basic salary and the equivalent of their fixed specialist allowance. This means that the doctor who does many procedures and decides to opt for the CS programme will in fact have a pay cut as he would be earning much less compared to the time when he was a full time clinician where he would earn much more from the procedures he would perform. So, compared to his counterpart who does teaching, the clinician teacher gets extra remuneration compared to the clinician researcher. Money should not be an incentive for research, but we should have a sense of fairness and ensure a level playing field between the clinical teacher and the clinical researcher. This disparity should be set right especially when advocating a role for research in our institutions, since we are talking about becoming Academic Medical Centres (AMCs).

Protected Time for Research

The time honoured way for allocation of protected time in most departments is to allow the staff to take several afternoons or mornings off to do their research work. The NMRC had some years ago structured in buying the Principal Investigator's (PI's) time from the institution to allow the PI to have protected time for research. This protected time is factored in as part of the NMRC grant wherein the PI specifies the number of sessions he needs a week for the research project. The NMRC would buy the sessions from the RH and reimburse them so that new staff could be hired by the RH to do the clinical work of the PI. The money for protected time for a few PIs could be put together to hire a consultant or a few registrars as replacement staff. However this scheme was abandoned subsequently as the RHs were not able to find staff to fill the vacancies. The result was that the staff not doing research had to work doubly harder and the scheme became unpopular and was removed by the NMRC.

Presently, for the CS scheme in the RH, the CS can spend up to 70% of his time in research and NMRC would reimburse the RH for the time spent on research. For the CR, he can spend up to 30% of his time on research and the RH would be reimbursed. The problem arises when a registrar has to be given one year study leave to pursue an NMRC scholarship in research, usually abroad where he or she would be trained in an area of research. Some Specialist Training Committees (STC) are reluctant to recognise that one year as a year of clinical training and may insist that the trainee spends an extra year, i.e. the 4th year for an extra year of clinical training. Presently, those interested in research training would have to accept this situation where they would lose out in seniority and remuneration. One way to compensate such individuals would be to pay them the salary of an Associate Consultant in the 4th year even though they are still doing a Registrar's work. The money could come from the NMRC or the NRF through MOH. Some of these doctors may want to pursue an MD or PhD after their exit certification, or they could also apply for the CS or CR programme.

However, there are some disciplines that recognise the one year spent in research as part of core training, i.e. a compressed 3 year training programme incorporating research before exiting at the end of 3 years. The 3rd year of training is usually spent abroad where the trainee spends a year in the research lab and in between he or she is also exposed to clinical practice in the overseas centre and would benefit from the broad range of clinical exposure during the time spent abroad. In fact, this was the system we had when we did our 3 years training for the FRACP in Nephrology from 1976 to 1988, where we spent our 3rd year of core training at the Royal Melbourne Hospital with Professor Priscilla Kincaid Smith under the Colombo Plan Fellowship, the equivalent of our HMDP nowadays. About 50% of our time was spent in research and the other 50% on clinical work. In the USA today, residents can also spend 50% of their time in research and 50% in clinical training. Perhaps our Specialist Training Committees (STCs) could follow suit and allow accreditation for time spent in research up to a year as long as the trainee's clinical progress is satisfactory.

Recruiting More Doctors for Research

With the present climate of shortage of doctors due to the changeover to the Residency Programme, there will be less doctors able to take time off for research. But if we are to become AMCs, research is a necessary pillar we have to build. In time, all RHs will have universities linked to its campus like what is happening to SGH with Duke-NUS GMS. The Imperial College will be linked to Tan Tock Seng Hospital (TTSH). In Duke-NUS GMS at the Outram Campus, there are many research staff holding faculty positions, hired by Duke-NUS GMS who need the necessary clinical link up with our Clinical Departments in

SGH in order to have access to clinical material for their research work. The Clinical Departments in SGH have to seek an alliance with these researchers so that our doctors can spend time in the research labs at Duke-NUS GMS and obtain training in research while they work in collaboration with their Duke-NUS GMS research staff while tapping on the clinical material from SGH. In this way, doctors in the RH can have training in research and engage in research projects and in time grow a vibrant research culture in the symbiotic relationship between the RH and the University. Through this arrangement, we can increase the number of doctors from the RH doing research. These doctors can also apply to become CS and CR after they have acquired the necessary research training. This will in turn spawn the seeds of research in the RH by increasing the number of doctors involved in research and increasing the number of research publications and with higher impact factors. The Duke in USA is also in the forefront of clinical drug trials and the doctors in the RH can also tap in on this expertise. In time to come all RHs could follow this model, thereby increasing the number of CS and CR and our RHs should well be on the way to becoming AMCs.

Maintaining the Right Balance for Clinical Workload, Teaching and Research

On an average, clinical work for most doctors would occupy 70% of their time and for teaching and research about 20%, with 10% spent on administration. Some may choose to spend up to 30% on teaching or research. With the Residency Programme, many doctors are given faculty positions where they are appointed to adjunct positions where they are made adjunct professors and are also remunerated. The adjunct research positions are taken up by the staff recruited from overseas. They are salaried by the University and A*Star, which also pay for their scientists and other research technologists through the research grants. For our doctors interested in research, they can also apply for the CS programme where they can spend up to 70% of their time in research or as CR where they spend up to 30% in research.

However, one big difference between doctors appointed as adjunct teaching staff and doctors involved in research as CS or CR is that the teaching remuneration is in addition to the usual salary, but for the CS and the CR, their salary remains the same or even less if he or she does many clinical procedures. The NMRC only reimburses the portion of the basic salary of the CS or CR. Most of the time, the money is also not spent to recruit new staff as there is the problem of recruitment, so the clinical work of the CS or CR has to be undertaken by some of the other doctors in the department. As for the CS or CR himself, now that he is doing less clinical procedures for which he could earn extra professional fees, he therefore actually suffers a loss of salary due to loss of professional fees from the procedures that he could have earned, as mentioned earlier. NMRC or the NRF in paying for the portion of the CS's or CR's time spent in research, 70% or 30% as the case may be, should also compensate the researcher for the income loss from professional fees due from the clinical procedures which he would no longer be doing as a researcher. This is to ensure that the researcher does not suffer a loss of income compared to what he had been earning before he opted for the CS or CR track. We have also known of some departments where the promotion of the CS to Senior Consultant was also delayed and the Head of Department considered the time spent in research by the CS as time taken away for which he should have spent in the wards to gain more clinical experience. This should not have happened since the CS or CR is still in touch with clinical work. It is not as if he was doing 100% research full time and had totally lost touch with clinical work.

With the presence of the University on the campus of the RH, the lure to clinical teaching by the doctors in the RH have improved with many of them being appointed as part of the teaching faculty of Duke-NUS GMS, but for researchers, despite the large funding from the NRF, their lot has not improved. It would appear that what is needed would be a mandate from MOH to implement all those suggestions which we had discussed earlier like protected time for research, increased remuneration of the researchers rather that loss of earnings because of decrease in number of procedures performed, including bonus incentives for high impact publications, etc. when they do get appointments as CS and CR.

In order for the various departments in the RH to become part of the fraternity of AMC, there should be a certain proportion of workload dedicated to teaching and research on top of high end clinical workload. The proportion of clinical work could be about 70%, with 20% for teaching and 10% for research in terms of work load and staff time spent on these 3 activities with perhaps about 5% factored in for administrative workload among the more senior staff which could be taken off from the clinical workload. For the individual staff member their career tracks could be different, one may choose to devote 30% of one's time to teaching and another staff member may devote 70% of his time to research. The truth about doctoring is that even though the doctor is reimbursed for 100% of his time spent working, many of us in fact put in 120% to 150% of our time at work. We are not paid for this extra time, neither do we ask to be paid. But we continue to do so because there is job satisfaction and we are healing the sick and helping the less well off by working in the RH which are public hospitals.

It is also about time that we make certain changes in respect of the kind of service we provide in the tertiary hospitals. The clinical workload in the Restructured Tertiary Hospitals should be tertiary clinical work as secondary clinical work should be serviced by the secondary RH and primary clinical work by the polyclinics. The time taken off from doing the usual secondary and primary clinical workload in the RH could be devoted to teaching and research. Teaching or faculty positions would be conferred by the University together with added remuneration. For research the money for CS or CR could come from the NRF through the NMRC or MOH with the added incentives of Professorships linked to CS or CR together with protected time and protected salary plus additional remuneration as bonus incentives for high impact publications.

The Biomedical Science Initiative in Singapore

In the year 2000, the government launched a new initiative, the Biopolis,[6] to make biomedical sciences one of the economic pillars in the country. Phase I had focused on the building up of biomedical science infrastructure and expertise, beginning with the set up of the Institute of Molecular and Cell Biology followed by the Genome Institute, Bioinformatics, Institute of Bioengineering and Nanotechnology, Stem Cell Consortium, Institute of Clinical Sciences, etc. All these were situated over an area of 2 million square feet and more than $500 million was invested. There were more than 2000 scientists and more than 20 private companies involved. Phase II in 2005 saw an additional 400,000 square feet to Biopolis and the work included 2 more buildings for corporate labs. Phase III of the Biopolis buildup commenced in the 2007 and has just been completed in 2010.[6]

Translational and Clinical Research

In 2006, the government decided to make Translational and Clinical Research (TCR), a key focus of the Phase II initiative. TCR was included as part of the Ministry of Health's mandate. From 2006 to 2010, for the National Research and Development Budget, the Cabinet allocated $13.55 billion to the Research, Innovation and Enterprise Council (RIEC), of which $5 billion was set aside for the National Research Foundation (NRF). TCR itself attracted $1.55 billion from the NRF, A*STAR and MOH.[7]

With the infusion of more funds into TCR, it means more funding is now available for doctors to participate in clinical research. Apart from the CS Programme, there is the Clinician Investigator Programme.[6] The clinician ideally is one who is fairly senior and has had a broad based experience in a particular specialty and able to recognise clinical problems requiring solutions through research. He would be in a position to formulate appropriate hypothesis for TCR. His actual hands-on research training may be rather limited but he is a superb clinician who spends about 70% of his time in clinical work but is able to devote about 20% to 30% to his research projects. He could work in collaboration with other clinicians or research scientists or clinician scientists. The portion of his time spent in research would be funded from research funds which also includes funding for his research projects.

There are also various research training programme for interested doctors including the AST-PhD, MD-PhD and the MBBS-PhD scholarships supported by the NMRC and A*STAR.[6] Our young registrars or advanced trainees can also opt for the clinician researcher awards to pursue an MD or MBBS-PhD programme with funding from NRF through MOH. If they need an extra year (year 4) to complete their programme, the additional year can be funded by NRF through MOH. The objective behind all these exercises is to increase the pool of clinician scientists and clinician investigators.

The Next Exciting Lap in Biomedical Research and Development

In the first two phases, from 2001 to 2005 and 2006 to 2010, we have focused on building expertise, new drugs and new treatment. In the third phase, from 2011 to 2015 the links between researchers and industry will be augmented. Scientists will be loaned out to companies and industry will fund research. This will also mean that scientists will enjoy a higher remuneration in the private sector as opposed to government funding. Industry will also be able to utilise much needed talent of expertise trained through the government's initiative and expense, nurtured and supported by the many imported talents available at the Biopolis.[7]

Over the next 5years, the Biomedical Science International Advisory Council will infuse another $16.1 billion or $3.2 billion a year, which is 1% of Singapore's GDP, into biomedical sciences research.[8] Singapore is nurturing a research intensive and innovative economy. Industry's share of manufacturing output grew from 4% or $6.3 billion in 2000 to 10% or $21 billion in 2009. This is an entrepreneurial economy creating high value jobs and prosperity for the nation. Singapore is well on the way to the goal of spending up to 3.5% of the GDP like other compact, research intensive countries but we are still a far cry from countries which are replete with Nobel laureates. Nevertheless, we are positive that we will arrive one day.

However, here we would like to sound a note of caution with regards to churning money out of research and equating research with industry. For the doctor doing research, what

motivates him in his research is the overwhelming desire or quest to improve the lot of his suffering patients, to seek an understanding in terms of the cause or the pathogenesis of a disease and following this, a cure, as in the case of HIV or cancer including prevention through immunisation, as was the case for smallpox and poliomyelitis. This is a wholesome motivation to do research. Indeed this is altruism at its best. The crux of medical research therefore is poised along noble ideals and goals and not the path strewn with fame and riches. As we mentioned earlier, history is replete with the names of famous doctors who have sacrificed their sanity and lives in the pursuit of medical research in order to cure their patients afflicted by previously incurable diseases. So, on a personal note, we believe that the links between medical research and industry should be de-emphasised. We do not subscribe to the belief that our doctors pursue research to win patents and become directors of start-up companies.

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