Transferring Technology from Bench to Bedside: Practices, Barriers, Policies

Report

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2. Summary

In the frame of the ERA-Net Neuron initiative we sought to shed light on the topic of technology transfer with the aim to identify barriers to successful transfer and practices, and policies that would enhance the so called move from “bench to bedside”. Through interviews with stakeholders, analyzing the literature on the topic, surveys and a dedicated workshop we have highlighted many obstacles and barriers that make it difficult to translate between the researcher's bench and the bedside. We have identified 4 central themes in particular and highlight countermeasures (in particular those relevant for ERA-Net Neuron) that could be taken to overcome them:

- Discontinuity between the biological and the medical: This relates to the difficulty of moving from a model (animal, in vitro) to humans reflecting the fact that an illness is not a simple phenomenon but heterogeneous and complex. Furthermore it testifies of the language barriers and cultural differences between researchers and practitioners.
  Possible countermeasure: Funding collaborative projects between clinicians and researchers: funding schemes providing clinicians with dedicated timeslots for research.

- Cultural divide between Academia and Industry: The language barrier is equally obvious between the “fundamental” researcher and his/her industrial counterpart and appropriate platforms for dialogue are required.
  Possible countermeasure: Increased training of researchers in matters of technology transfer in order to facilitate dialogue; funding of joined projects between academia and industry, and setting up discussion forums/networking platforms between academia and industry on particular topics.

- Rethinking the role of researcher: There is a need to instill an entrepreneurial culture in today’s academic research and create incentives for researchers to pursue route for valorizing their research outcomes.
  Possible countermeasure: Rethinking incentive structures and performance measures within research institutions. Funders could lead the way by adapting peer review criteria.

- The need for appropriate support structures: Technology Transfer Offices (TTO) are essential but not always efficient and new models and infrastructures to facilitate technology transfer need to be set up. A systems thinking is required and there is no ‘one size fits all’ solution.
  Possible countermeasure: Seek inspiration in working models and make use of ongoing European initiatives (IMI and EATRIS)

3. Introduction

The aim of the ERA-Net NEURON, launched in 2007, is to promote the development of a European strategy for research in the area of disease-related neurosciences. In Europe, disorders of the brain account for around one-third of the total burden of all diseases. Therefore, the link between research on such diseases and their active treatment is of outmost importance.

The present report looks at the challenges and difficulties of moving knowledge and technology from "bench to bedside" and back again. How can we improve the links between basic research and clinical research, between the laboratory bench and the bed of a patient in a hospital? Nowadays, efforts are put into increasing the use of knowledge and technology to produce medicines, tools, or treatments in order to better care for patients.

Yet, many obstacles and barriers make it difficult to translate between bench and bedside. Some talk about transfers being "lost in translation" (Mankoff et al. 2004). These barriers include: the difficulty of moving from a model to humans; the heterogeneity and complexity of illnesses; ethical, practical and financial considerations; language barriers and cultural differences between researchers, practitioners and the industry. There is, in other words, a "discontinuity" between the biological, the medical and the industrial– and it is this discontinuity that deserves both academic and policy analysis.

In this report, we highlight the various kinds of challenges and issues raised by technology transfer - cultural, technical, legal, political, financial, structural, etc., including, for instance: the produceability/marketability of products; the need for IP-related policies; for early dialogues between researchers and industry; for trusted advisory groups and confidentiality agreements; for centres/forums/networks; for joint projects between academy and industry. This report highlights these issues by presenting and discussing data collected via several methods (see section 3): expert interviews, a scientific workshop and a quantitative survey without seeking to provide a comprehensive view of all possible barriers to translation.

4. Findings

The discontinuity between the biological and the medical

The essential idea behind the term “from bench to bedside” is to create links: links between basic research and clinical research; between the laboratory bench and the bed of a patient in a hospital. It is commonplace to start with the following observation: the links between laboratories and hospitals are problematic; they are too slow, too long or too expensive. Too slow, since the time between the discovery of a new molecule or a new therapy, and the time this new molecule is actually used in practice is several years. Too long, since we must travel between several disciplines, several institutions, several professions, etc. Too expensive, since the development of a molecule costs millions. (Only about 5% of new molecules eventually become marketable products.)

The stated aim is to better understand diseases and to discover or improve diagnostic or therapeutic approaches for patients. To this end, efforts are put into increasing the use of knowledge and technology to produce medicines, diagnostic tools, or treatments in order to better care for patients. In doing so two ends are sought: to improve health and to make money with biomedical knowledge. Both senses of the term translational are thus to go "from bench to beside" (that is, towards medical practice) and "from bench to market" and thus translating knowledge into marketable products and commodities (see Woolf 2008).

In his book *Inventing Biomedicine* Gaudillière (2002:370) even speaks of a "discontinuity between the biological and the medical": "Between the universe of controlled experimental systems and the variability of the body; between models and that which they are supposed to be models of; between the relative ease of discovering something and the appalling complexity of therapeutic innovation [...]." To overcome this discontinuity, the importance of intermediaries, including "clinician-scientists” is crucial (Atkinson-Grosjean et al. 2009). The ideal candidate is someone with a double training: in both the care of patients and in a research laboratory (Kong et al. 2010). These clinician-scientists - whose role remains to be clarified and whose status remains uncertain (Ogilvie et al. 2010) – can address some of the problems of translation because they speak two "languages", that of research practice and that of clinical practice.

This was echoed in the interviews where one interviewee calls to:

“fund **positions for medical professionals** with an adequate salary that attract them to go into research and give them a realistic time slot to perform animal and human trials. This will significantly shorten the time between the first idea and the proof-of-concept studies” (Interviewee6).

In view of the fact that most medical applications need 10 - 15 years to come from a research based idea into an approved medical device the usual funding periods of 3-4 years seem inadequate and more long-term support is required.

Technology transfer between public research and the private sector

Potential problems in transferring technology from an idea from Academia to a product used by a pharmaceutical company relates to their different perspectives: academia perspective is based on basic science and on the scientists' ingenuity and novelty, while in the industry perspective there is a constant need for breakthroughs from academia to solve real life problems with products that may be sold for profit.

Here is an extract from one of the interviews with a person working in technology transfer, who mentions, first of all, the problem of valuation and a problem of public versus private:

"there are two fundamental issues (…) One is the fact that technology transfer always suffers from information asymmetry. In other words, I do not know what I have is worth to the other side. (…) So technology transfer is always a problem because the guy who transfers to somebody does not know how much it is worth to the recipient. (…) And that means ***you cannot extract the value*** *of it (…) The other one is this problem around* ***public good versus private good****. (…) so what is the philosophical principle around funding something that will end up as a private good versus funding something that will end up as a public good. (Interviewee1)*

But producing a commercial good calls for 2 questions to be addressed:

"technical feasibility evaluation of a project (…) divides into two issues. One is ***produceability****: can we actually produce this if we get it? And secondly, is there a* ***market*** *for it?" (Interviewee 1)*

Therefore, universities need to provide guidance, awareness, incentives, funding, etc. for getting scientists to embark on those steps. A workshop participant explained in detail all the steps: "is it really needed that we make an entrepreneur out of every researcher? I think the responsibility of universities and of funding agencies should be to make sure that public money is not wasted and to create at least an awareness of important developments which have been taking place in the funding procedure of the universities. And maybe also to provide at least some consultancy to people who want to be entrepreneurs. (…) I see a lot of small start-up companies, starting up and failing. And the failure is usually always the same (…): they do not know what to do. Even if they get

money, it is not a guarantee of success if you do not know what are the next steps to bring a drug towards the clinic. There are different failures, wasting of money, there are failures doing too much research and not focused on that you have to go to the clinic, and finally you have a wonderful research paper but you are still in the pre-clinic phase, and the money has gone and nobody trusts anymore because you have wasted your time with IP protection and everything. So here we should create awareness on the other hand and help a little bit with very simple information".

For the budding researcher/entrepreneur the first issue is really "knowing what to do next". "Being a company means that you are not doing only basic science. You are doing additional experimental work that will answer the questions that are needed for the next milestone. (…) This is how we work: we work from one go-no-go decision to the next one. And it is somehow clear what is needed to answer for the next step. (…) So being a company gives you the responsibility of what you are doing. You are not an academic anymore; you are a company so you have to do what you should do".

Thinking about the "middle piece" is important: "it is really, really hard to develop drugs (…) what universities and academia institutions are good at is innovating and making basic fundamental discoveries. What drug companies are good at doing is bringing drugs through clinical trials into the market. What is missing is that middle piece. It is really how do you translate that basic research into the innovations that are actually going to succeed (…) How do you foster an innovation culture that allows to go a little further than academia? So you can say this is a good target, this is a good compound. But then getting it transferred to a pharmaceutical company that can take it to the clinic and do so with a higher likelihood of success that there is actually going to be a drug at the end of the day. (…) The failures are incredibly expensive and incredibly frequent (…) I think focusing on whether we can do a better job on having an impact on human health by fostering innovation in an academic setting or in an industrial setting is really how we have to focus the conversation rather than how do you maximise how much money flows to the institution versus how much flows to the company".

Our interviewees identified a number of "good" models such as the VIB in Gent (where there is a good relationship between industry and academia; see case 2). One additional example is the EATRIS network of biomedical translation research centers within the frame of the ESFRI roadmap and the Innovative Medicines Initiative which also covers pharmaceutical innovations for the therapy of brain diseases.

One of the interviewees has also identified reasons for why other models do not seem to work. If the main driving force is economic opportunity where the key objective is to generate new business and there is not really a keen interest to use and apply knowledge

gained from research themselves in the health care system of their own country, then the model is likely to fail.

Better dialogue between public research and the private sector

Of course, many mention that there needs to be a dialogue between the various partners involved in technology transfer. Here is how one of our interviewees described this issue:

"there is **early involvement** of the guys who at the end of the day will end up owning it anyway. I think it is very important to try to get these people on board straight away – you know - big pharmaceuticals or some other. (…) that means that if they are aware that there is a competitive scenario, then they are likely to end up entering into the agreement earlier (…) you need to involve industry extraordinarily early in the discussion project (…) around the viability of the idea from an industrial perspective. (Interviewee 1)

In order to facilitate early dialogues between researchers working in a university and private firms, there is a need for **training of fundamental researcher** in questions of valorization and you need **trusted advisory groups, confidentiality agreements**, etc. Researchers who spend time in the industry do better when it comes to dealing on a technology transfer deal [expectations and timing] and having a business body in the Academia to deal with the business aspects also facilitates communication between Academia and Industry.

The cultural divide between public research and the private sector

Two of our interviewees also talked about culture being a fundamental issue in technology transfer:

*"you have got to promote this **culture** (…) it depends on the culture of the director of the institute, of the vice-chancellor of the university, of the head of the lab, which kind of policy is being done there" (Interviewee 2)*

*"(there is a difference) between Europe and the West, England and the continent, north of Europe and South of Europe (…) **the fundamental difference is a purely cultural one**" (Interviewee 3)*

For example, the US are described as a place where the research landscape is more competitive, where more emphasis is put on valorisation and where there is a true entrepreneurial culture, which is not really prominent in Europe.

One interviewee relates it back to the need of **political will**: "it is not a matter of money; it is a matter of political will". This boils down to several issues. In terms of whole countries, the country interested in technology transfer has to be ready to accept new developments in the medical field, and there should be collaborations between firms and government. In terms of science and technology policy, it is important to have a valorisation policy.

What can be done to bridge this cultural divide between Academia and Industry?

"*the funding of **joint projects between academic and industrial research** to support applied research and development of highly innovative and high-risk projects. (…)* [would be] *a very valuable tool from our experience is the **set-up of nation-wide competence networks for specific diseases** which bring together the best experts in basic biomedical research and clinical application in this area. Such a network is also a valuable partner for companies doing research in this field" (Interviewee 5).*

A new role for scientists?

Awareness in matters of tech-transfer is a key issue, but for technology transfer to happen, there is a need for motivated scientists. But - and this is an important point - reward structures and cultures need to be adjusted to people who might move in and out of academia (and, conversely, in and out of industry): *"You really do need dedicated people who want to see their ideas translated into something that is concrete (…) And we have to make this easy and we have to make the OTT office align with the academic rewards so that innovation is rewarded. Right now if you start a company and (…) and you want to take 3 months off to deal with, you know, what you have to deal with on the business issues, not only do not be rewarded academically, you are going to take a hit academically. It is not going to add to your likelihood of promotion to associate or full professor; it is actually going to work against you. And so we are having these internal discussions right now about how it is that we want to promote innovation on the one hand. We want to be known as a place that innovates. But on the other hand we have a culture that actually acts at odds to that*".

The situation in Spain, has been described along similar lines: "*it is rather difficult to jump from a university to a company because if you jump you lose your position (…) The system in my opinion should be coherent and consistent (…) Because it is not only a matter to sign a contract (…) So that means that it is necessary in my opinion in addition to change the legal framework in a broader sense. It is also necessary to change the attitude, the minds of the people that are directing the universities because otherwise the system will remain as such. (…) So it is a fundamental issue in which you need to change minds and you need to work on contractual research and this is not a bad thing. In some countries in Western Europe it is considered second class research (…)*". In other words, academic cultures, priorities and reward structures need to be adapted to the aims of technology transfer **and to valorise the job** of the researcher in this respect.

Supportive tools

Offices for technology transfer are a possible structural solution for fostering technology transfer. One of the workshop participants states: "instead of each individual investigating – looking around trying to think who will be the best partner – (…) people can stay focused on the research rather than imagining that they are going to be millionaires". Yet, in practice these OTTs are usually not well staffed in terms of human resources. "Manpower is an issue there. They have at the most 3 people that I know of working on reports and patents and all that and change too because of frequent turnover".

Another issue is that people who work in OTTs have quite a range of tasks and partners to deal with: "they have a lot of kind of mundane, bureaucratic things to do: material transfer agreements for example have to be vetted by the OTT so if I want to send a ... to somebody they have to do that, if I want to receive one they have to deal with those issues; institution to institution, academic institution to academic institution that is part of their mandate, negotiating on partnership agreements is part of their mandate and then negotiating with IP suppliers, external firms that will actually do the IP work – is part of their mandate, and then making decisions on what is worth gaining a patent production is part of their mandate. So it is a lot". Also there are allegedly underpaid and not incentivised. The situation in Canada, for instance, was described as follows: "it is really more a legal requirement than actually facilitating the

development (…) And they are not well manned and there is no incentive. So really it is a very dysfunctional entity."

In fact, the numbers provided by Fazackerley (Fazackerley et al. 2009) show that filing patents, licensing or spinning out companies is but a small part of the activity of these offices (between 4 and 6%).

Another problem is that patents cost a lot of money: "one of the things that I think drives the universities' requests for upfront payment is that the management of IP is very expensive endeavor. (…) So you have got a conundrum here where it may be costing you 100,000 dollars a year to have a patent maintained, but you are not getting any income from it." Also, along the process of innovation, the kinds of patents filed might become increasingly expensive: "early patents might be largely protective or method-based – you see a shift to more confidential patents as time goes by and they become more narrowly focused around a certain class and (…) you can really spend a lot of money. (….) And the way the revenue flows when it finally comes in often does not support the OTT office directly in a way that there is a return on investment so it is a really difficult problem".

One potential solution that was raised was that government could step in here: "So one way around this, is maybe take the patenting process and find somewhere – maybe this is a role for government or some sort of quasi-government agency to perform this purpose on behalf of the promising research that it supports. And then, if having protected it, (…) there is some understanding that it transfers out to industry, that is one of the first things paid back. So that is a legitimate upfront payment because that is a value that you are bringing to the discussion. But it is a barrier right now until we work our way around it".

New models are emerging and perhaps the most striking one is the Open Access policy of the Structural Genomics Consortium. The SGC does not seek to protect its discoveries but releases them to the public domain for unrestricted use providing a open basis for the development of new applications, drug targets *etc* (see case 2).

Imperial college went down another route by transforming in 1986 their tech transfer department in a company (Imperial Innovations see case 3). Imperial college remains the main partner but links with other Universities and investors have been created.

Systems thinking

There needs to be structures and systems thinking, taking into account the "bigger picture". "Unless there is a structure that is going to work with them - and not an OTT that is

somewhere out there - then we are going to be missing out on a lot of potential discoveries that could be translated into a commercial interest".

One participant explained that there is a need for people to be "systemically looking at the situation (…) with the ministry and the pharmaceutical industry and look at how we can improve the whole process of drug trial. You know where there is the whole business of ethics approval from multi-centred... which is a mess and contracts. So we are starting to look at this from a systemic point of view because the government has recognised that it is a barrier to economic development".

Another participant followed up on this, commenting: "It is necessary that politicians have a comprehensive canvas in which it is not only academia or industry or innovation. You need to put all the canvas in which adhere different pieces. And different pieces in a comprehensive, successive order. (…) a vast comprehensive picture in which all the pieces are put in the proper order and not only considered separately and second pricing policies is a critical matter and technological sales application issues by the public policy".

In a similar spirit one could see the idea of translational centres and health forums: **"Translational centres** combining research expertise with the knowhow are needed for result exploitation, both in technology transfer and translation into clinics. Industry tends to retreat from research or focuses on late phases of trials, public hand has to fund early phase research. There is a need with regard to infrastructure e.g. biobanks, research into biomarkers and animal models. In order to increase trust and willingness to cooperate, a **neurosciences/mental health forum** could be helpful" (Interviewee 4). The added value of **thematically-structured** research institutions and units would also be their focus as in the eyes of the experts, technology transfer across a too broad range of domains is likely to fail.

Conclusion

We have identified several barriers to technology transfer and the key to successful transfer of technology is effective communication on various levels (between clinicians and researchers, academia and companies *etc.*) to overcome these barriers. Equally important is an understanding of the expectations of the process and expectations of what is needed to make this all possible. Strategies for overcoming barriers include cultivating support,

planning, education, cost-benefit analysis, understanding organizational structure, facilitating change, being sensitive to the effects of technology on users.

In particular, to overcome the discontinuity between the bench and the bedside, collaborative projects between clinicians and researchers could be funded. New funding schemes (e.g. funding for a clinical replacement) could provide clinicians with dedicated timeslots for research, enabling them to undertake more substantial projects. Long term research support to take basic research further along the paths towards applications is also required as Neuroscience applications need substantial amount of time to come to fruition. ERA-NET Neuron has decided to address this issue by repeating calls on a particular topic every 4 years so that successful applicants can submit follow-up projects in the subsequent call.

To enable a better linkage of academia and industry, trusted platforms of dialogues need to be created. Creation of competence networks/thematic clusters of partners from industry and academia seem to provide an appropriate environment for dialogue on a national level but adopting this model on the European scale may be difficult as IP issues become increasingly more complex with growing number of actors and countries. Nonetheless funding joined private-public research projects which could also be coupled to discussion forums between academia and industry could be one measure to enhance this dialogue on the European level. Ideally these competence networks would also bring in experts clinicians.

In view of the lack of 'entrepreneurial culture' within Europe more work needs to be invested in raising awareness and provide guidance to the academic research in questions of technology transfer (e.g. IP training, writing business cases etc). The objective should not be to make entrepreneurs out of every researcher but to create an environment where motivated 'academics' can be supported to bring their ideas to the market and where researcher wanting no part of this can hand off their idea to someone who has the ability to take it further. The reward system within academia, which seems primarily focused on publication output, does provide little incentive for researchers to pursue this route however. Here research funders could lead the way by acknowledging the merit of researchers' efforts in valorizing their research through adapted peer review criteria.

It is clear that no 'one size fits all' model can be found for successful technology transfer within Europe and within the individual member countries. TTOs are important elements in such as system but their current mode of action does not seem to be very efficient. It is essential to get a comprehensive view of whole systems and all the pieces required to bridge the gaps of technology transfer and to establish interacting infrastructures that help establish an efficient flow from basic research to medical applications. Inspiration can be drawn from the various models presented herein.

Conscious of the gaps in technology transfer, two initiatives have developed in Europe that need be mentioned here. The European Advanced Translational Research Infrastructure in Medicine (EATRIS, case 5) and the Innovative Medicines Initiative (IMI, case 6) both aim to accelerate transfer from basic research to clinical application. IMI is supported by the European Union and the pharmaceutical industry association (EFPIA) and has the aim to provide support for networks building between industrial and academic

experts and collaborative projects. EATRIS is one of the biomedical infrastructures identified European Strategy Forum on Research Infrastructure (ESFRI) seeking to bring "under one roof" the competences and resources to make translational research possible. Both initiatives are still relatively young and whether they succeed remains to be seen. But both initiatives seek to address the hurdles identified herein on the European level.

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5. Cases

CASE 1: The *Vlaams Instituut voor Biotechnologie* (VIB), Belgium

The Vlaams Instituut voor Biotechnologie (*Flanders Institute for Biotechnology*) is a research institute established in 1995/1996. Its overall objective is to "strengthen the excellence of Flemish life sciences research and to turn the results into new economic growth" and its main goals are strategic basic research, technology transfer policy to transfer the inventions to consumers and patients, as well as scientific information for the general public.

VIB is a decentralized institute linking several departments and labs in Flanders. Researchers work in research departments of four Flemish universities (Ghent University, Katholieke Universiteit Leuven, University of Antwerp, Vrije Universiteit Brussel). Hence, instead of integrating Flemish research groups in one place, the Flemish government's concept was to strengthen international competition via structural long-term financing, to combine competences, while sustaining integration into local universities. Neuroscience is one of the research areas of VIB (out of 11 research areas in the life sciences).

Apart from carrying out research activities, VIB's other major area of activity is commercial exploitation of the results of this research through submission of patents, collaboration with industry and the creation of innovative companies. VIB's dedicated technology transfer team comprises 16 people, all of which are located at the VIB headquarters. The activities of these staff are licensing, business development, analysis, and technology transfer.

VIB has been involved in the creation of spin-offs from academic research groups, and since its creation in 1996, 11 start-up companies have been founded. In 2010, 471 employees worked in VIB start-ups. VIB also hosts laboratory and office space in its incubators (in Ghent and Leuven).

In 2004, Philippe Busquin, EU research commissioner, called VIB "a model for research in Europe". And, in fact, Wallonia, the French-speaking region of Belgium, is adopting a similar model than VIB (see Hodgson 2010). In 2009, VIB launched VRTC, a 5 module cross-disciplinary training package in the life sciences, including, for instance, courses on scientific networking, on technology platforms, on technology transfer and entrepreneurship, etc.

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Further reading

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CASE 2: A structure genomics consortium

The SGC (Structural Genomics Consortium) is a not-for-profit, public-private partnership with the main objective to solve large scale 3D protein structures. Their mandate is to investigate human protein and proteins from human parasites that could serve as potential drug targets and they should thus provide a pre-competitive fundamental science basis for subsequent drug discovery. With over 1200 protein structures released by September 2011, SGC has been very productive (up to 50% of all structures deposited into the Protein Data Bank per year) and has become a reference in the field. SGC pursues an Open Access policy and their findings are released into the public domain without restriction on use.

The SGC regroups the expertise of the Universities of Toronto and Oxford and the Karolinska Institutet in Stockholm and is supported financially by GSK, Eli Lilly, Pfizer, the Novartis Research Foundation, the Wellcome Trust, and Canadian granting agencies.

One member of the workshop testifies on the well functioning of the SGC:

"*Academia and government funding of research needs to explore completely totally new models, one of which is championed by a group at the university of Toronto which is very, very successful - it is called a structure genomics consortium. And they solved the three-dimensional structure of a lot of proteins and they have actually been responsible for about over 50% of all of the protein structural work that has been done in the last 6 years. And everything that they do is* ***open-source****. So the minute that anybody in their consortium makes a discovery it is out. It is exactly like the human genome project. It is out there in the public domain. It is largely funded largely by CIHR and others (…) and it is also funded by 6 pharma companies that are willing to have their money lead to discoveries that are then potentially shared by their competitors. So they are advocating an open-source model for all government-supported research and then it is that knowledge that becomes available and people that are able to take advantage of it (…) They are getting information that is much, much more mature than they would have if they just took some idea that I have for a drug and try to work with it. (…) And it is flying in the face, of course, of the IP model and the more traditional business model for getting a return from the money (…) And so if the public through government participate to a much larger degree in the open sharing of all of the knowledge creation – maybe the quiproquo is that drugs should not cost this much. (…) And*

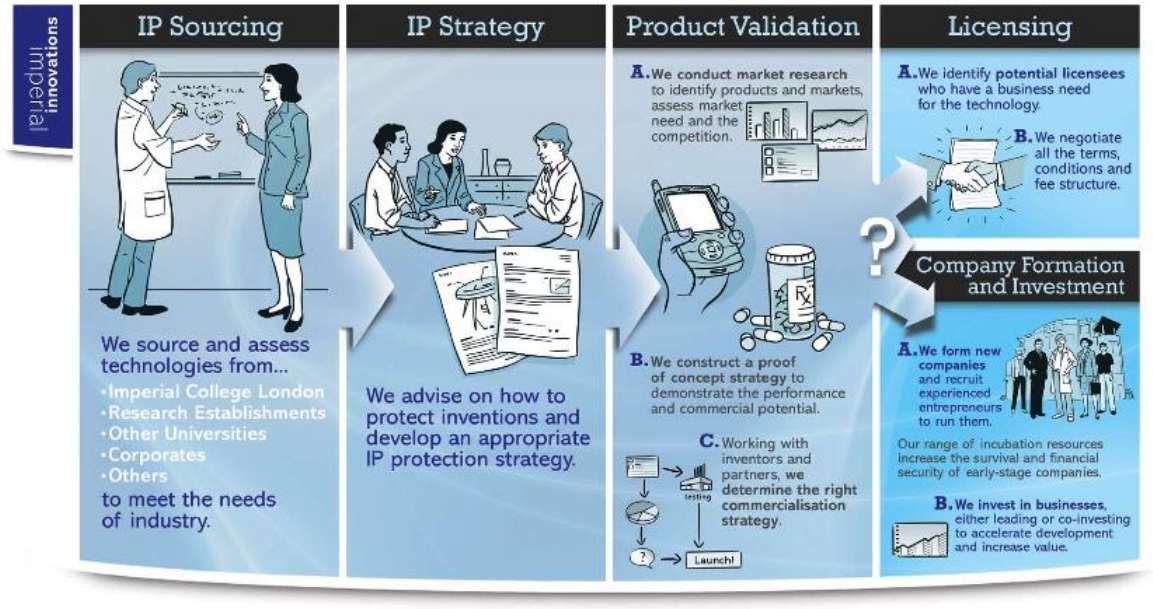
so it is possible and the bulk of the money comes from foundations. It is also complicated because it is 3 countries involved: Canada, the UK at Oxford and then there is another node in Scandinavia (...) they have solved more of these structures than for anybody else in the world".

Sources

Structural Genomics Consortium website: http://www.thesgc.org/about/what_is_the_sgc

CASE 3: *Imperial Innovations* at Imperial College London

Imperial Innovations was set up in 1986 at the Imperial College London. Its missions are to realise the commercial potential of research carried out at Imperial College and to foster technology transfer and company incubation – it boasts "an established process for translating research into marketable and beneficial products" and "an integrated approach across the whole commercialisation process – a model which is greatly admired throughout Europe". The services offered include: technology sourcing, intellectual property management, commercial assessment of intellectual property, market analysis, licence negotiation, incubation services and space, investment.



While the main partner of *Imperial Innovations* is Imperial College, the company also invests and liaises with other universities (Oxford, Cambridge and University College London). During its history, it has transformed itself from a university department to a separate company. It has developed the College Incubator which provides laboratory and office space for early-stage companies. Today, *Imperial Innovations* employs around 30

people and is divided into an executive team (3 people), a Ventures & Investment Team (17 people) and a Technology Transfer Team (8 people). The two latter teams have people working in mainly two sectors: healthcare and technology. There are a number of noteworthy points: the high number of staff, the different specialization of staff (life science, medicine, engineering, etc.), the various roles performed, the various backgrounds of staff (industry, investment, entrepreneur backgrounds), and the broad remit of the company. It is also worth stressing the peculiar set up of the company, being described as one of those "TTOs that do not take a legalistic approach, instead concentrating on brokering relationships between business and academia and running them as businesses in their own right" (Fazackerley et al. 2009). Knowing, for instance, that the recruitment of experienced and talented start-up managers is a serious problem, *Imperial Innovations* see the construction of management teams as an important part of their remit (Fazackerley et al. 2009).

The funding scheme is described as follows: *Imperial Innovations* puts a small amount of cash into a company (for example £250.000 of seed funding) with potentially other investors; then, if the business opportunity seems promising, around £5 million are raised for the company to work on the technology and to build a team; then they move into subsequent rounds of funding. Susan Searle, chief executive of *Imperial Innovations*, explains "It's being able to follow through that's quite key (…) In the UK there's a real disconnect in terms of investors behind companies. There are lots of seed investors who will put up the early amount of money and really experienced venture capital firms who will come in later. But there's this gap which a lot of companies fall into" (quoted in Cooper 2010). Hence, one of *Imperial Innovations'* missions is to fill such gaps.

Imperial Innovations has established equity holdings in approximately 80 companies, the majority of which are spin-outs arising from technologies developed at Imperial College (a lot of which are biotech or medical devices firms). It has made over 100 IP agreements. In 2006, *Imperial Innovations* (turned into Imperial Innovations Group plc) was floated on the alternative investment market of the London stock exchange – the first such move of a technology transfer company in the UK history. In a sense, it itself was "spun-off" from Imperial College. In late 2010, it was revealed that *Imperial Innovations* had agreed to advise on the creation of an accelerator space for spinout companies at the Queen Elizabeth Olympic Park as part of the new *East London Tech City hub*.

Sources

- "Technology transfer company established by Imperial College London to float on the alternative investment market of the London Stock Exchange" (press release), 20 July 2006 http://www.imperial.ac.uk/college.asp?P=7996

- *Imperial Innovations* website, http://www.imperialinnovations.co.uk

- Cooper, Rachel (2010) "Imperial Innovations is helping one college profit from discovery", *The Telegraph*, 19 December 2010 (http://www.telegraph.co.uk/finance/newsbysector/banksandfinance/8210746/Imperial-Innovations-is-helping-one-college-profit-from-discovery.html)

- Fazackerley, Anna, Martin Smith and Alex Massey (2009) *Innovation and Industry: The Role of Universities*, http://www.policyexchange.org.uk/assets/Innovation_and_Industry.pdf

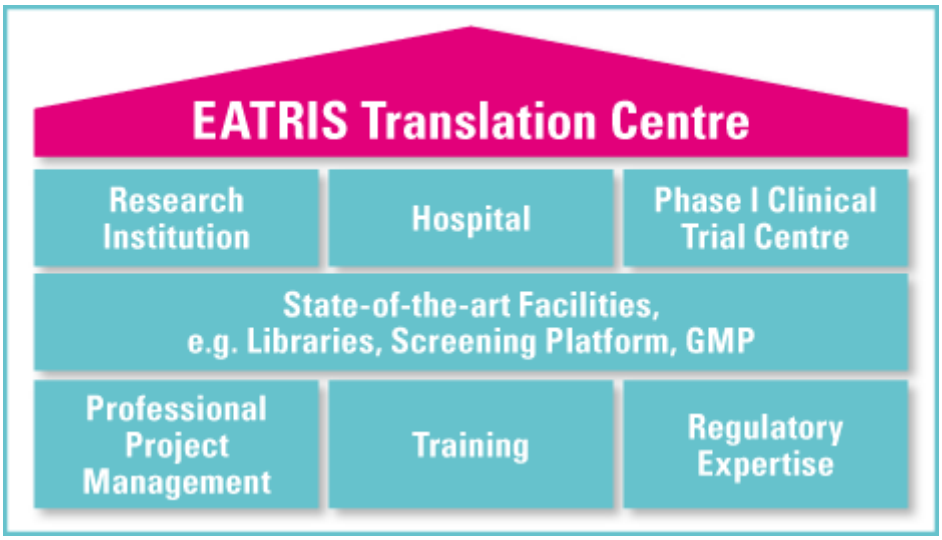
Further reading

- Nicolaou, Nicos and Sue Birley (2003) Social Networks in Organizational Emergence: The University Spinout Phenomenon, in *Management Science*, Vol. 49, No. 12, pp. 1702-1725

CASE 4: EATRIS, European Advanced Translational Research InfraStructure in Medicine

EATRIS is one of the biomedical infrastructures identified European Strategy Forum on Research Infrastructure (ESFRI) and is currently funded under FP7. The aim of the European Advanced Translational Research InfraStructure in Medicine, EATRIS, is to provide infrastructure to accelerate the translation of basic research results into new diagnostics, treatments and diseases prevention strategies.

EATRIS acknowledges that a fragmentation of the research environment exists and seeks to overcome this by forming a pan-European network bringing together top translational research institutes in the academic sector



As stated on its website, EATRIS aims are *to improve performance and conditions for translational research by*

- *providing easier access to research & development facilities and translational know-how for all scientists and researchers in Europe*
- *overcoming fragmentation along the translational research path*
- *fostering knowledge exchange and standardisation*
- *providing training programmes for the next generation of translational researchers*
- *facilitating and encouraging cooperation between academia and industry*

The scope of the EATRIS Consortia is built around five technology areas (called product groups) which were identified in discussions with various stakeholders (academia, SMEs and large biotech/pharma companies):

Vaccines
Imaging and Tracers
Biomarkers
Advanced Therapy Medicinal Products (ATMP) and Biologics
Small Molecules

In order to fulfill its aim EATRIS invests in key infrastructure high-quality physical resources (so-called bricks), such as state-of-the-art imaging and animal facilities, basic

research facilities and Phase I clinical trial centres. Furthermore they will provide guidance for translational research through in-house expertise in scientific and project management and offer educational and training programs in translational research for scientists, physicians and science-oriented clinicians.

The Implementation Phase of EATRIS is foreseen during the period 2011 to 2014 and EATRIS should be fully operational by 2015. Sustainable long term financing for building and operating EATRIS will be ensured through national funds and seeking additional funds from European and private sources.

It is expected that the primary users of the infrastructure are basic biomedical researchers and clinical scientists located at universities and research institutions which bring their discoveries further along the innovation chain and thus "de-risk targets" for the industry.

Sources

http://www.eatris.eu/

Bioforum Europe 1-2, Feb 2010: **EATRIS Infrastructure Accelerates Translation**

CASE 5: IMI, Innovative Medicines Initiative

With a €2 billion euro budget, the Innovative Medicines Initiative (IMI) is Europe's largest public-private initiative. The joint endeavor of the European Union and the pharmaceutical industry association EFPIA try to address perceived insufficient investment in R&D and the increasing complexity in drug and medical application development, by providing funding for collaborative projects and networking platforms between industrial and academic experts.

Their main focus lies on support for safety and efficacy, knowledge management and education and training project which are selected through open calls for proposals. The research consortia benefiting from IMI funding may vary in their constitution but are normally formed through partnerships amongst large biopharmaceutical companies (members of EFPIA), SMEs, patients' organisations, universities and other research organisations, hospitals, regulatory agencies and other industrial partners. Although calls are open to all of these actors, it is prerequisite that all project related work is undertaken in Europe.

Sources

http://www.imi.europa.eu

6. Annexes

Abstracts from "Workshop on transferring technology from bench to bedside: Practices, Barriers and Policies"; Montreal 20th of January 2011

TECH TRANSFER AT TEVA, Dr. NORA TARCIC Senior Director of Drug Development at Teva Pharmaceutical Industries

Potential problems in transferring technology from an idea from Academia to a product used by a pharmaceutical company relates to their different perspectives: academia perspective is based on basic science and on the scientists' ingenuity and novelty, while in the industry perspective there is a constant need for breakthroughs from academia to solve real life problems with products that may be sold for profit. The key to successful transfer of technology is effective communication. Equally important is an understanding of the expectations of the process and expectations what is needed to make this all possible. Strategies for overcoming barriers include cultivating support, planning, education, cost-benefit analysis, understanding organizational structure, facilitating change, being sensitive to the effects of technology on users. Some of the "ways around these challenges" - researchers who spend time in the industry do better when it comes to dealing on a technology transfer deal [expectations and timing] and having a business body in the Academia to deal with the Biz aspects also facilitates communication between Academia and Industry.

FINDINGS SO FAR AND FOOD FOR DISCUSSION | Dr. MORGAN MEYER Postdoctoral Researcher at the Centre for the Sociology of Innovation, Ecole des Mines de Paris

Moving from "bench to bedside" (and back again) proves difficult. So how to improve the links between basic research and clinical research, between the laboratory bench and the bed of a patient in a hospital? Nowadays, efforts are put into increasing the use of knowledge and technology to produce medicines, tools, or treatments in order to better care for patients. Many obstacles and barriers make it difficult to translate between bench and bedside. People sometimes talk about transfers being "lost in translation". These barriers include: the difficulty of moving from a model to humans; the heterogeneity and complexity of illnesses; ethical and practical considerations; language barriers and cultural differences between researchers and practitioners; debates around GMOs. Some even speak of a "discontinuity between the biological and the medical". To overcome this discontinuity, the importance of intermediaries, such as "clinician-scientists" – that is, people who speak two "languages" - is crucial. Technology transfer raises a number of issues and challenges - cultural, technical, legal, political, financial, structural, etc., including, for instance: the produceability/marketability of products; the need for IP-related policies; for early dialogues between researchers and industry; for trusted advisory groups and confidentiality agreements; for centres/forums/ networks; for joint projects between academy and industry.

AXOGLIA THERAPEUTICS, THE FIRST BIOPHARMACEUTICAL COMPANY IN LUXEMBOURG: HYPE OR REALITY | Dr. DJALIL COOWAR CSO and co-founder of AxoGlia Therapautics SA

AxoGlia Therapeutics is the spin-off of a scientific collaboration between two academic institutions in Luxembourg and in Strasbourg. The research developed by the organic chemistry and neurobiology laboratories gave rise to innovative molecules with dual anti-inflammatory and CNS regenerative capacities. One compound proved to be active on an animal model of Multiple Sclerosis (MS) and AxoGlia was incepted to bring a drug candidate from these molecules up to late preclinical studies before an out-licensing to pharmaceutical companies. We decided to develop AxoGlia's activity in Luxembourg due to strong financing initiatives from the government who wants to develop the biotechnology sector. However, we have cumulated difficulties through the years of our drug development starting with the long delay in the negotiations with the academic institutions to in-license the patent of these compounds. After that, the pharmaceutical industry was less keen to in-license preclinical project for MS and we updated our business model to bring our lead candidate up to a clinical phase 2a. Problems then arose to finance this clinical development as new pharmacological data are now required by Venture Capitals to demonstrate the competiveness of AGT0048 on the MS market. Five years after AxoGlia's inception, difficulties to develop a lead compound are still slowing down our evolution.

COMMERCIALIZATION RESEARCH AT THE MONTREAL NEUROLOGICAL INSTITUTE | Dr. PHILIP BARKER Professor in the Departments of Neurology & Neurosurgery and Anatomy and Cell Biology at McGill University, Chair of the Centre of Excellence in Commercialization and Research Committee

The presentation from Phil Barker focused on Canada's Science and Technology plan and specifically examined the role of the Centers of Excellence in Commercialization and Research (CECR) , a federal program designed to accelerate the commercialization of leading edge technologies, goods, services in priority areas where Canada can significantly advance its competitive advantage. One of these areas is neuroscience and the Montreal Neurological Institute (MNI) was an early recipient of CECR funding. The MNI received $15M in funding and the presentation described the administrative and scientific oversight procedures that were established to use the funding to propel innovations likely to yield innovative commercial and translational developments. Cultural issues that act as potential barriers to successful commercialization program in an academic environment were identified and addressed. Over 30 projects were funded for one year, with most being renewed for 2nd and 3rd year funding. Projects that succeeded in the commercial domain were largely medical devices, device/software enhancements or those provided unique research services to the research or medical community.

INVENTION, RE-INVENTION, AND INNOVATIONS: FACILITATORS AND BARRIERS IN REHABILITATION TECHNOLOGY TRANSFER | Dr. JOYCE FUNG Associate Professor School of Physical and Occupational Therapy at McGill University

There are many opportunities for technology transfer existing in physical medicine and rehabilitation, whereby the enhancement of functional recovery and quality of life is frequently considered. The health and well-being of a person depends on the complex interactions in physical, cognitive and social domains, which can be examined using the framework of the World Health Organization's International Classification of Functioning and Disability. Any impairment in body structures and functions can give rise to a disease that restricts a person's ability to perform daily activities and reduces a person's social participation, depending on the intricate, co-existing personal and environmental factors. The restoration of balance and mobility functions in stroke rehabilitation was used as an example to illustrate these complex interactions. An innovative motion base was invented to perturb upright balance during standing and walking in any combinations of six degrees-freedom-of-movement. Virtual environments were generated by computer graphical simulations and projected in 3D by optical instruments. A self-driven treadmill was instrumented on top of the motion base, and synchronized with scene progression to achieve an optimal sense of presence and immersion as a person walks in the virtual environment. Thus, a powerful system incorporating virtual reality technology was created for the evaluation and intervention of balance and mobility disorders. The potentials of maximizing functional gains with various biofeedback devices were discussed. The talk was concluded by discussing the contribution of research centres and networks, and the various roles assumed by funding agencies, academic and health care institutions, as well as industrial partners in the process of technology transfer.

DEVELOPMENT OF NANOPARTICLES TARGETING SPECIFIC BLOOD BRAIN BARRIER TRANSPORT SYSTEMS FOR IMPROVED DRUG DELIVERY OF ANTI-ALZHEIMER COMPOUNDS | Prof. MANFRED WINDISCH CEO and founder of JSW LifeSciences

Treatment of Alzheimer's Disease is so far an unmet medical need. During the last decade all new drug development programs for AD Failed. One reason is the blood brain barrier limiting the transport of active compounds to the target. To overcome this hurdle in this project participating groups are working with nanoparticles (NP) based on human serum albumin carrying specific ligands for transport systems in the BBB. Due to additional iron load transport, accumulation and degradation of these particles can be tracked by MRI. The NPs can be packed different active compounds. As a model the consortium is using an active compound which failed in clinical trials because of problems with BBB penetration Transgenic mouse models of AD will allow to verify the expected amyloid lowering effect of the drug. In case of a positive outcome these nanoparticles can be widely used, and the exchange of specific ligands will allow targeting individual brain areas of interest. Our approach could later also be used to develop new and specific imaging methods.

7. Methods

Workshop on technology transfer

In order to explore the above issues, a workshop dedicated to technology transfer was organised during the ERA-Net NEURON meeting in Montreal on January 18, 2011. The workshop brought together 50 participants (including 6 speakers), was chaired by Dr. Frank Glod (Fond National de la Recherche, Luxembourg) and was hosted by the Fonds de la Recherche en Santé Quebec Montreal.

The persons that presented their research/activities that day were:

- Dr Nora Tarcic Teva Pharmaceutical Industries Ltd, Israel
- Pr Manfred Windisch JSW-Research Forschungslabor Gmbh, Austria
- Dr Djalil Coowar AxoGlia Therapeutics SA – Luxembourg
- Dr Philip Barker Montreal Neurological Institute and Hospital, Canada
- Dr Joyce Fung McGill University, Canada
- Dr Morgan Meyer Ecole des Mines de Paris, ParisTech, France

The idea of the workshop was to bring together people to discuss about the translation and transfer of biomedical research and technology. Here were the questions that guided the workshop:

- How can we improve the flow of knowledge from bench to bedside as well as from bench to market?
- What are useful policy measures, best practices, programmes, etc. to improve the applicability and usability of knowledge in the life sciences?
- What concept of technology transfer should we put to practice and work with?
- What are the best practices for technology transfer? What can we learn from success stories in the various fields?
- What makes technology transfer difficult? What are the barriers that have to be considered and surmounted?
- What types of measures and policy programmes are adapted to foster technology transfer?

Unless noted otherwise, the excerpts quoted in this report are taken from this workshop.

Interviews

In order to deepen our understanding of the problem, six semi-structured interviews were conducted with specialists in the field:

- François Meyer; 2002-2006 CEO of Centelion SAS, 2000-2002 Senior Vice president R&D France Aventis Pharma, Board member and advisory board member of various Biotech companies
- Patrizia Luchetta; Ministry of the Economy and Foreign Trade, Luxembourg, 'Project leader of Biotech programme'
- Goran Roos; Founder of Intellectual Capital Services in London. One of the founders of the modern field of intellectual capital
- Nora Tarcic; Director and Senior Project Leader, Product Development Section of Teva Pharmaceutical Industries
- Celine Tarraube, Ian Cresswell; Luxinnovation the National Agency for Innovation and Research in Luxembourg

Literature Review

A short literature was carried out on the themes of "translational medicine", "technology transfer" and "bench to bedside". These fields and topics being quite broad, and the literature on them quite extensive, our aim was to provide some "feel" of what constitutes the main challenges and issues of technology transfer in the life sciences, and to provide a more general background for the empirical data collected.

Questionnaire

The survey results can be found here:

http://www.surveymonkey.com/sr.aspx?sm=uKKejQWO024rEv5wm6fLcOIaLAtXz0BwLBRtzBZ_2bDgA_3d