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Chair

Mrs. Joy Smith

Standing Committee on Health

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● (1530)

[*English*]

The Chair (Mrs. Joy Smith (Kildonan—St. Paul, CPC)): Good afternoon, ladies and gentlemen. Welcome to the health committee. We're very pleased to have you here today.

I want to welcome you to committee, Mr. Boulerice. I hope I pronounced your name correctly. It's a pleasure to have you here today.

I also want to welcome Dr. Sellah's guests, Leah, Tasha, and Sarah. I understand you're from the University of Toronto.

A voice: That is true.

The Chair: Welcome. I'm so glad you came to our health committee today. It's one of the most fascinating committees, but we're kind of biased about that.

We have two fantastic witnesses you're going to hear from today, as well. We have, from Genome Canada, Dr. Pierre Meulien. He's the president. And from Structural Genomics Consortium, we have a PowerPoint from Dr. Aled Edwards, director and chief executive officer. Welcome to both of you.

I'm going to ask Dr. Meulien to begin, please.

Dr. Pierre Meulien (President and Chief Executive Officer, Genome Canada): Thank you very much.

[*Translation*]

Thank you, Madam Chair.

Thank you, members of the committee.

I will give my presentation in English, but I would be glad to answer questions in French, if you'd like, during the question period.

[*English*]

Members of the committee, on behalf of Genome Canada I'm very pleased to contribute to your study of technological innovation, including best practices, in health care in Canada.

As you may know, genomics is the science that aims to decipher and understand the entire genetic information of any organism, any living thing. As such, this science is fundamental to all biological research and can help us gain better insight into a wide range of questions about life. Genomics is a relatively young science, and its potential is rapidly being tapped by new technologies, a reality that has powerful implications for health care and many other sectors in Canada.

Before I present some of the applications and implications of genomics technology in health care, let me briefly say a few words about Genome Canada. Genome Canada is a not-for-profit corporation dedicated to developing and applying genomics science and technology to create economic wealth and social benefit for Canadians. We work in close partnership with six regional genome centres and with the federal and provincial governments, academia, and industry.

We invest in and manage large-scale research and translate discoveries into commercial opportunities, new technologies, applications, and solutions in key life science sectors of the economy. These sectors include human health, of course, but also agriculture, fisheries, forestry, environment, energy, and even mining.

In all of our work, we make it a priority to consider the economic, ethical, environmental, legal, social, and other challenges—we call this GE^{3}LS research—and opportunities related to genomics. We do this to help policy-makers and others understand the broader impacts of the science and to accelerate its acceptance and the uptake of innovations into society.

Since 2000 the Government of Canada has committed $1 billion towards our mandate, and we've succeeded in leveraging this investment to secure a further billion dollars in co-funding over the same period to support our work. More than 60% of that $2-billion total has been invested in health-related genomics research and applications.

We are already seeing a return on that investment as witnessed by Canadian genomics findings that have saved lives, improved treatments for patients, and reduced health care costs.

The biggest genomics game changer for health care in Canada and elsewhere is the unprecedented technological progress leading to our ability to read a person's DNA, which is his or her personal code of life. The time is rapidly approaching when each of us will be able to quickly and inexpensively have our personal genome sequenced and available for analysis for a variety of health-related queries.

The very first human genome was sequenced at a cost of $3 billion and took thousands of scientists over 10 years to complete—and that was done in 2003. Less than 10 years later, any one of the many established genome sequencing centres in the world—and there are three world-class centres in Canada—can do this job in a few days for only $3,000, and the cost is getting cheaper by the week.

Few, if any, other areas of science and technology have undergone such a rapid evolution—where the cost of a significant operation has seen a millionfold drop within a 10-year period.

Obviously, there is considerable speculation among health professionals, policy-makers, and patients regarding how this relatively new, now-accessible technology will be used in the clinical setting. How will this information be analysed, by whom, who will own the data, and how on earth will we integrate this new world of medicine into an already stressed health care system?

In order to answer these questions, we first need to understand what our personal genome can and cannot tell us about our individual health status and our susceptibility to certain diseases later on in life.

The degree to which our genes impact our health differs greatly depending on the condition or disease in question. At one end of the spectrum are single-gene disorders, some of which are extremely rare and others more common, such as cystic fibrosis, certain forms of bleeding disorders—you know the term “hemophilia”—and Huntington's disease. For these diseases, the genetic component is the main, if not the only, driver of the disease. In other words, no matter what environmental factors are at play, if you're unfortunate enough to have a defective gene set for these kinds of diseases, you will most likely have the disease.

● (1535)

At the other end of the spectrum are the much more common chronic diseases, to which many genes may conspire to increase a person's likelihood of falling prey, but which may only manifest themselves if environmental factors are added to the mix.

Type 2 diabetes is a prime example of this situation. There is a complex genetic aspect to most cases of type 2 diabetes, but the disease will express itself preferentially in those who, perhaps, don't exercise regularly, have poor nutrition, and/or consume abnormally high levels of alcohol. Incidentally, the incidence of type 2 diabetes in particular is escalating and driving health care costs to unsustainable levels in most developed countries.

All this is to say that decoding our personal genome plays a pivotal, albeit partial, role in combatting diseases and addressing challenges in the health care system.

So what is actually happening now to make the most of this technology? Our health authorities and provincial and federal ministers of health are asking good questions and challenging the promoters of genomics technology as to how we can integrate it into the health care system in an economically sustainable manner.

Genome Canada, in partnership with the Canadian Institutes of Health Research and the regional genome centres, is rising to this challenge. Last year the Minister of Health and Minister of State (Science and Technology) jointly supported us in launching a new $150 million large-scale applied research initiative in personalized health.

We asked project teams across Canada to deliver proposals that would make use of the best technology available in the world to address serious medical needs, which included an economic rationale as to why health authorities should be proactive receptors for this new technology. In other words, to be successful, the projects would need to justify how they would serve the interests of the health care system as a whole. We are delighted that in the very near future, we will be in a position to announce the results of this competition.

Already genomics is being applied in our heath system in specific areas. For example, genomics is being used to decide appropriate treatments for many forms of cancer. Canada is playing a prominent role internationally as the coordinator of the International Cancer Genome Consortium.

Canadian genomics research has also helped prevent infant fatalities. A Genome Canada-funded study discovered several years ago that there was a genetic basis behind some forms of sudden infant death, linked to the use of codeine by breastfeeding mothers. As soon as this study was published, both Health Canada and the United States Food and Drug Administration changed labelling for codeine, banning it from being used in the postnatal period.

The field of adverse drug reaction is ripe for genomics-based, evidence-driven application, as here once again the genetic component is very dominant in many cases. This is significant given that adverse drug reactions cost the Canadian health system $7 billion per year. Imagine if we could cut that figure just by half.

We will see other major developments over the next three or four years, as progress made in genomics will impact health fields as diverse as epilepsy, autism, schizophrenia, cardiovascular disease and stroke, cancer, and many inflammatory diseases.

This is just the beginning. Canada is beautifully positioned to reap the benefits of this technology, notably because of the world-class research capacity that's been created here over the past decade. The huge potential for efficient integration into the health system is thanks to a research-intensive health-delivery infrastructure and the fact that Canada has some of the best disease-specific clinical research networks in the world.

That being said, there certainly are some broader challenges, which the committee is familiar with, that Canada must overcome to develop and maintain a financially sustainable, modern health care system and to facilitate the integration of genomics efficiently and effectively. These include such things as electronic health records; efficient, modern, and harmonized provincial health technology assessment systems; education and training modules for health professionals in genomics and alterations to the medical school curriculum; a more mature interface between health research and health delivery; and productive research partnerships with the private sector.

Furthermore, patients and patient advocacy groups will have an important voice going forward, and individuals will have to be accountable for maintaining and monitoring their own health and for adjusting behaviours as they go through life. Although challenging, this concept will be key, and government funding will be required to encourage Canadians to partake in healthy living practices.

● (1540)

Genome Canada would like to thank the committee for its time and consideration.

The Chair: Thank you, Doctor. That was an extremely insightful presentation. It's astonishing how quickly this industry is growing, isn't it?

Thank you for your presentation.

Now we'll go to Dr. Edwards. I understand you have a PowerPoint presentation.

Dr. Aled Edwards (Director and Chief Executive Officer, Structural Genomics Consortium): Yes, we don't know how to talk without them anymore.

I took a page from the politicians' playbook today. I'm not going to answer the question you asked, but I'm going to answer the question I wanted you to ask.

I'm a professor at the University of Toronto and a professor at the University of Oxford, and I run a public-private partnership between Canada and the United Kingdom, and soon Brazil. It's an early-stage drug discovery. It's how to make medicines faster.

I want to get the point across about why we're doing this and the role Canada can play as a leader and not a follower—and we don't often lead.

I think you know the main problems we want to address. You guys, certainly at this time of year when you're making budgets, see the health care costs growing at 6% per annum—at least your provincial counterparts do. There is not a lot of freedom to operate in terms of where you spend your money. As well, we're all getting older, and per person we're not having as many kids, so there's going to be a demographic that works against the Canadian system.

Part of the rationale to invent new medicines is that they're cost-effective. Good medicines do reduce health care costs, but unfortunately the industry as a whole—that's across the world—is not inventing new medicines, particularly for diseases that are chronic and that afflict us all.

Novartis is one of the best drug companies in the world and they're not doing any more research in Alzheimer's disease. They say it's too hard.

In our country, 25% of the population is going to be over 65 in 2050. In Japan, 41% of the population is going to be over 65. That's when chronic disease starts, so we're in trouble.

I'll never be a politician, because there is this script, and I never follow it. So therefore as a politician I would be in big trouble.

Part of the problem with the downsizing of industry is that Canada loses. Boehringer Ingelheim has closed its research facility in Montreal. Merck has closed its research facility in Montreal. This is happening in all the western countries.

If industry is not inventing novel medicines, it's moving to countries that have more customers, so that's China and India. If you don't have anything new to sell, you sell what you have to more people. It's a perfectly logical business move, but it doesn't help us. It doesn't help us with Alzheimer's, and it doesn't help us with the diseases that are going to get us.

I'd like you to, at the end of this, not come out depressed. I think there is a real way that Canada can have an impact on these global problems, not the problems of Canada, but the problems that are in Canada and the world. One of the big problems is who is going to invent the new medicines.

Industry is now wondering why it can't invent new medicines. There is a common agreement among academics like me—professors—and doctors and industry that we just don't know enough about human biology. That's the reason. There is no innovation crisis. There is no hidden agenda. When we start to test medicines in people, most often they don't work, because we got the hypothesis wrong. So we think if we take this drug, our diabetes will go away, and—damn—it doesn't. We have no way of predicting that before we test.

So industry is saying, “Let's collaborate with those smart professors”, but I think they're out of luck, because the professors around the world and the global system of discovery are actually failing the community.

You will remember that the human genome was done. We have 20,000 genes. That's the code. You can say, “Cool! How much research is there on gene number one, gene number two, gene number three?” You can then plot that on a curve.

This graph shows 518 genes and the research per gene. What the hell is going on? Why is everybody working on the same ones? That's because the way we reward ourselves as professors is by obtaining peer recognition. Our friends have to think we're good. It's not money that drives us; it's how well we are doing in our field. You know, “I'm the big stud and I published on this and I get to go to all of these meetings and things”. If you work where no one else is working, no one is going to invite you to Barcelona to give a seminar. No one is going to ask you to do this. You're not going to get any awards. Do you know how to succeed in my field, in professor-land? Work where everyone else works. If you happen to be a little better, you get all the papers.

● (1545)

The reality, though, is that if I get hit by a bus tomorrow, it will not affect the world one bit because there are 100 other people doing the same experiment. It's the system by which we, in Canada, the United Kingdom, the United States, reward professors—it gives us tenure, gives us grants—causing us to be extraordinarily myopic in our research. We all focus on the same thing.

Despite what Pierre's organization has done, and opened up the genome, it can't change our behaviour because we're not driven.

My mom is a grade one teacher. She said, “I thought you scientists like to discover stuff.” I replied, “I know, Ma. That's not it, exactly. We like to get invited to Barcelona and give seminars”.

The problem in translating this basic research into applied research is, now I’m in industry—for example, I work for Merck and I want to cure cancer. Who do I talk to? The smart Harvard professors with the bow ties. Well, how did they get to be Harvard professors? They are successful in working where everyone else is working. So they're going to tell me, “At Merck, you should work on this protein that is a higher priority”. The same Harvard professor goes to all the other companies and tells them the same thing. What happens? All the industry works on the same proteins that we work on. It's an incredible duplication of effort.

Around the world, Canada spends $1 billion to $2 billion on biomedical research. There is $100 billion spent around the world, all focused on 10% of this stuff. There's this whole swath of biology not being investigated. The consequence is that when we go to patients with a putative Alzheimer's drug and it doesn't work, we lose because we didn't know enough. We didn't know enough because we're not investigating the unknown. We're not investigating the unknown because the system doesn't let us. This is the problem I have encountered, and have tried to overcome in our organization.

Another thing you need to understand is that it's not getting any better. Comparing the number of research papers and the number of genes, you can see that before the genome—the monumental event in 2002, and five years after, and last year, or 2009 when I did it last myself—the research is still on the same darned ones.

Of the papers published by professors and doctors, 65% are on the proteins that were hot in 1992. We are very slow to move from our comfort zone. Scientists like to fondle their problems, and we really get into it, and we can't let go. This is to the detriment of a lot.

Now, most fields are like this, but we can quantify this because the genome has only 20,000 genes, and you can actually count them.

So this is the innovation crisis on the planet, not only in Canada.

It was this that caused us to be quite concerned. As one of many examples, here is a science paper. In essence, it says, “These two funny names, map three...are two genes that are important for cancer”. Look where that one lies on the “importance-ometer”.

Forty years since Nixon's war on cancer, a trillion bucks has been spent on cancer research. You know as well as I if you've had a sick relative that it's hard to cure, and we didn't even know about that gene just published last year. We've been working on the same ones everyone has, like the drunk looking for the keys under the street light.

This is a serious problem.

What our organization did was to say that if industry finds it too risky to work down there and academia finds it too risky to work down there—because the systems don't allow us to—what if everybody put a little bit of money into a pot? We said that the purpose of this organization is to learn about the unknown, to get a flashlight and march off into the unknown. Industry and academia both agree that we don't know enough about biology, so there's common interest, and indeed, that's what we did.

What's the opportunity for Canada, here? As researchers, we do this thing, we're extraordinarily competitive. I mean, we work under the light and we're sometimes better, sometimes worse. We're extraordinarily competitive in Canada. We have really smart people. But they're all working in the same area, in general.

How can we in Canada have the biggest impact on the planet, which will have the biggest impact on chronic disease, and which will have the biggest impact on our health care system?

● (1550)

I say, why don't we let America and the EU and China fight for that piece and elbow each other out of the way? One can be first, and the rest can follow.

If we have one dollar to spend, why would we spend it competing with the EU and the United States and China, when we could take a risk? The trouble is, you don't get any credit for working out there as professors so you need to invent a new system, because we promote people based on their ability to compete under the light. We fund people based on their ability to compete under the light. The world works that way and we're not going to change it. You know, there are some things about politics that don't make sense and you can't change it. You have to live with it, and you have to live with that.

How do you get people to go out there? What we did was convince eight—and now nine—companies to donate money to the organization that I run. We have a couple of hundred people in Toronto and at Oxford who do research and put it into the public domain without patents, all for knowledge discovery, all addressing the most important problem in health, which is how to find out more about the human body, and how to find out more about disease so that when drug companies make medicines, they work, and the cure for Alzheimer's will not be by guessing but it'll actually be logical.

It's a completely different system for supporting biomedical research. I think Canada has a unique opportunity. The United States can't do this because they're so fixated on patents, and every university wants to be “the one” and build shiny buildings and compete. The EU can't do it. To get anything done you need 37 signatures from 37 ministers of this or that, and you might as well shoot yourself.

Some hon. members: Hear, hear!

Mr. Aled Edwards: I think we can be incredibly more nimble in this country. We have the game plan to do it. We have all these companies from around the world—these are global heads of R and D coming to Canada to do this. We're starting a new project with Genome Canada to try to find cures for children with rare diseases, something that's really difficult to do. We're doing it in a pre-competitive manner, sharing all the data, not filing for patents, and industry is funding it. CIHR, Genome Canada, and CFI are all helping.

In an incredible happening in July, six R and D leaders from Tokyo and the United States from some of these companies are coming to Ottawa to talk about doing one drug discovery program without patents, from idea all the way to testing in humans.

I think this has the potential to completely transform the way the world discovers medicines. It needs to be done, and I am confident that Canada can lead. If we do it, we will definitely have more efficient innovation in the discovery system, more medicines more cheaply on the five-year to ten-year horizon. We'll get the research arms of pharma back in our country. They're coming. The head of R and D of Takeda, from Tokyo, is coming here in July. The head of R and D from Glaxo in London is coming here in July. We'll be able to focus this research on the unknown, and it's a way for Canada to lead and not follow and not be under that street light with everybody else.

I'm sorry for not telling you what I was supposed to tell you, but I think that was fun.

● (1555)

The Chair: Actually, Dr. Edwards, it is refreshing to hear that. You're an expert in the area, and this is why you're before the committee today, teaching the rest of us. So we thank you very much.

I'm sure there are lots of questions from the committee, so we're going to begin.

We're going to begin with Dr. Sellah.

[*Translation*]

Mrs. Djaouida Sellah (Saint-Bruno—Saint-Hubert, NDP): Thank you, Madam Chair. I appreciate your kind words for my witnesses.

Mr. Meulien and Mr. Edwards, I understood your presentations perfectly. Thank you for coming here to explain genomics to us, as well as its importance and its impact on the health of Canadians.

I fully understood what Mr. Edwards was saying about Canadian practices and the importance of being a leader rather than a follower. That being said, a serious concern remains when it comes to genomics, and that is the confidentiality and security of genetic information. There are also concerns about the potential for discrimination based on genetic information by employers and health insurance companies.

In 2008, the United States adopted the Genetic Information Nondiscrimination Act to protect individuals against discrimination related to their genetic information by health insurers and employers.

Could you comment on the challenges related to the patenting of genetic discoveries? And do you think that Canada should pass legislation similar to the Genetic Information Nondiscrimination Act in the U.S., to protect Canadians against genetic discrimination?

Dr. Pierre Meulien: I think the situation that exists in the U.S. and other countries that have adopted new legislation on genetic information discrimination is quite different than Canada's. Canadians are, in my view, well protected. I know that some will disagree with me, but I don't think we need to change the law. I think we are protected.

The situation in the U.S. is very different because people there are not entitled to a publicly funded health care system. That is not the case in Canada. Here, everyone is entitled to receive health care.

[*English*]

I think it's a very different situation in Canada and in other countries that have adopted a law. Canada has a health system that is solely funded by government. People do not have an issue when they go to find health care: they will be treated. In the States, it is completely different.

Please note that the law in the States did not include life insurance. Life insurance was excluded from that law. It only protects people who cannot be discriminated against because of their genetic predispositions when they go for health care and they have to pay for health care insurance.

The situation in Canada is very different from those in other countries that have adopted a law. I'm not a legal person, but if it is the Canadian Human Rights Act or whatever law that protects the Canadian citizen, the Canadian citizen is well protected from genetic discrimination, I think, as it applies to health services.

● (1600)

[*Translation*]

Mrs. Djaouida Sellah: Thank you.

In that case, does Canada have guidelines for the patenting of genetic discoveries?

[*English*]

Dr. Pierre Meulien: In terms of patenting genetic information, I believe that Canada lies between Europe and the United States. As you know, even in the United States there are High Court rulings that are in waiting as related to patents on breast cancer genes and other genes that have been patented in the U.S. In Europe, patenting of genes is not permitted. There is no patenting of genes allowed in Europe.

In Canada, it is I think in between the two. We promote a very open access model for all of the genetic information we produce in terms of the projects we fund, so I believe that as we go forward there will be so much data out there that most of the data will be in the public domain for the patents on the front end of the value chain.

What my colleague here didn't say is that the Structural Genomics Consortium is responsible for producing over 25% of the world's whole domain of protein crystal structures, and 25% of that knowledge comes from his group. None of that is protected. It's one of the rules of the Structural Genomics Consortium. They will not patent any knowledge within that structure.

If pharma companies want to compete further down the value chain, they can, and they will. They'll bring in knowledge that's available to everyone, bring that in-house, and then use their proprietary technology to build a case.

I'm sorry. I'm going on.

The Chair: No, that's fine. Thank you, Doctor.

I'll just give you a little signal when we're over time, Dr. Meulien.

Dr. Pierre Meulien: Please do.

The Chair: We'll now go on to Mr. Lizon.

Mr. Wladyslaw Lizon (Mississauga East—Cooksville, CPC): Thank you very much, Madam Chair.

To be honest, I don't know where to start.

Thank you, gentlemen, for coming here to the committee.

First I would like to ask, Dr. Meulien, if that government fund that you mentioned is still ongoing? Was it renewable every so often?

Dr. Pierre Meulien: On the personalized health competition?

Mr. Wladyslaw Lizon: Yes.

Dr. Pierre Meulien: This $150-million amount of money was gathered through different funding sources, including CIHR. CIHR put in over $20 million, we put in $45 million, and provincial governments put in a lot of money. Pharmaceutical companies are joining some of these projects, so there's private sector money in that $150-million pot. We have not spent one dollar of that yet. Those projects are about to start. They will be announced by both the Minister of Health and the Minister of Industry very soon.

You will see when they are announced that each one of those projects will demonstrate value in a particular disease setting where we have an opportunity to move genomics into the clinical setting, from the academic lab into the clinical setting. That program will run for four years. We hope that we will be re-funded again from the federal government so that we can rerun that program in a few years' time.

● (1605)

Mr. Wladyslaw Lizon: You mentioned in your opening remarks that a special application of the findings in genomics in clinical settings will change the way that people are treated. In your view, how is it going to work? Based on some genetic code, will a doctor be able to assess the health risks of the person, and then that's how he or she will plan the treatment down the road?

Dr. Pierre Meulien: Yes, it's exactly that.

For any given disease, especially more complex diseases—cancer, epilepsy, autism, some of these more complex diseases—we're understanding that it's just not one disease, it's many diseases. Through the genome, we can classify whether people are type 1, type 2, type 3, type 4, or whatever stratification they lie in. Based on that molecular profile, the treating physicians will be able to say, “Well, you know this epileptic patient here, the last thing we should do would be to give that person anti-epileptic drug *x*. That's the last thing we should do, because all that's going to happen is that we will do harm to that person.” It will reinvent, if you like, the way medicines are prescribed based on an individual profile. We're all very different. In this room, we are all very different. We're going to react differently to different drugs. This is what the genome is telling us.

Mr. Wladyslaw Lizon: I have another question, but I will ask you when I have time.

I would like to ask you a question, Professor Edwards.

I really listened with interest when you described the problems we have in the research of genomics. What would you propose would be the best solution? Anybody who's not familiar with the issue would wonder why people don't get together and build 20,000 separate labs, give them money, and assign one gene to everyone. Would that solve the situation?

Dr. Aled Edwards: You should be in charge of health funding.

Voices: Oh, oh!

Dr. Aled Edwards: I think that's the ideal world, but then we have reality, and so it won't happen.

Mr. Wladyslaw Lizon: It's utopian probably.

Dr. Aled Edwards: Exactly.

What you have to find is common interest to go out there. What we've been able to do is attract the pharmaceutical industry. They paid $100 million to us to go into the unknown and not patent anything because it's the carrot that will allow academics to go work on the unknown. In large part, we would go there if there was the funding, if there was a mechanism to fund work in the unknown, but the way we allocate funding is by peer review, which is pretty conservative. I believe there's a huge appetite in the pharmaceutical industry, which spends about $30 billion globally on R and D, to spend money in basic research in the right areas.

Mr. Wladyslaw Lizon: Professor, if we took the pharmaceutical industry completely out of the picture and did that research in order to find out the causes of disease, then we wouldn't need pharmaceuticals. Is this something that science can go to find out?

Dr. Aled Edwards: Perhaps, but unfortunately the way we've let industry evolve is that pharmaceutical companies have a lot of skill sets that we no longer have in universities. It's just how the ecosystem evolved. So there are some problems that can only be solved in this part of the curve, in the unknown, by combining forces; by combining monetary forces, intellectual forces, and technology forces.

In America they can't do it because they all say, “Who's going to own the patent?” and then you talk to lawyers and then you shoot yourself. In the EU, it's “Who's going to do it?” and you have to get Lithuania and everyone to sign a common agreement and that'll take years. We can be nimble here and we've done it before. So on the insistence that pharma funds half, I think we have a great opportunity for Canada to be a leader of early-stage drug discovery in that area, provided we get cash from industry to do it, and no patents, and they will do it. And Canada will be the magnet for early-stage drug discovery, I'm convinced. We did it once. There are new projects starting with Pierre. I'm very optimistic.

● (1610)

The Chair: Thank you, Dr. Edwards.

Thank you so much. Those were very insightful comments.

We'll now go to Dr. Fry.

Hon. Hedy Fry (Vancouver Centre, Lib.): Thank you, Madam Chair.

You've presented a sort of Catch-22 situation in terms of getting pharma to put in, say, 50% of the money, not filing patents and working in those unknown areas we talked about. But about the unintended consequence of pharma, which puts in that chunk of money, saying it owns this information and is not going to share it with anybody else? That is where my thinking is going. Instead of opening up that information so everyone can see it and benefit from it, what we're doing is selling information to the highest bidder who then would patent it, own it, and go ahead and do it.

Dr. Aled Edwards: This is what the public sector is incredibly important for. If pharma got together, like the oil companies are getting together in Alberta to do the environmental stuff with no public sector involvement, who knows what industry would get up to? In these consortia, we're a registered charity. They give us a charity, there's a board of directors on which Genome Canada sits, and CHR, the Wellcome Trust in the United Kingdom, and we have governance rules that do not allow that to happen. So we set up a corporate structure that absolutely forbids it, and actually, pharmas are more willing to share than professors on many occasions.

Hon. Hedy Fry: Just to follow that trend, if you have rules that prohibit pharma from doing this, what is pharma's incentive for wanting to put in 50% of the dough?

Dr. Aled Edwards: Pharma's incentive is that its share price since 1950 has been dropping. Its discovery of new medicines has been dropping. It doesn't have the skill sets to work in the unknown. It thought professors should do it. So this is a relatively small amount of money for it—$10 million or $20 million—but it leverages funds from other pharma and it leverages funds from industry. It's paying $1 out of every $10 and it's getting completely innovative information and “freedom to operate” is the business word, because then they can take it and run internally.

Hon. Hedy Fry: That governance system is important for me to look at.

I'm just going to go back to the issue of genetic discrimination. I think you made a very important point in terms of accessing medicare or health care services. In Canada, there wouldn't be any genetic discrimination because universality—one of the five principles of medicare—states that pre-existing conditions, etc., do not preclude you from getting the care you need when you need it. But there is a concern from some people that it does not govern private insurance. For instance, you had car insurance and you had one accident and your premiums doubled; you had a second accident and your premiums tripled; you had a third accident and you're not insurable anymore. Private insurance companies that, say, do life insurance and other types of insurance are already doing that: if you're a smoker your premiums go up. How do you prevent that from happening in a country like Canada where it isn't access to health care services, but looking at other areas of insurance?

Dr. Pierre Meulien: That's an excellent question. I don't have all of the answers, but I know that some of the top lawyers in this country are working on it, and some within our projects. Each of our projects—and this will be true for the 17 projects we're going to announce soon in the personalized health competition—has integrated into it sub-projects that are to do with the ethical, legal, and social issues related to some of this new information we're discovering.

Al mentioned a project on rare diseases that Canada is actually leading the world on in this field. When we sequence people's genomes, families' genomes, with these rare genetic disorders, we're very successful in finding the gene that's causing that particular anomaly. But we're also successful at finding a whole host of other so-called incidental findings. We then have to decide what we should do. Are they actionable? Are they not actionable? Are they important enough to share with the family? Are they not? What's the legal architecture around that? What should we do about it? Those types of questions are being researched by social scientists and humanists within each of our projects.

With regard to this question, I know the Privacy Commissioner of Canada is looking at the particular point that you're driving. I think they've either just published or are just about to publish on some of those concerns. They've been working with the insurance industry on that very topic. I think we will have answers; I don't think we have all of the answers now.

● (1615)

Hon. Hedy Fry: Thank you. I want to ask one final question.

I want to thank both of you for bringing forward what I think are the most innovative presentations we have had to date. I think we're actually on the cusp of a revolution in medicine, and in understanding disease, etc.

However, once we move into this new mode of treatment using genetic information or genome information, who will pay for that? Currently, we don't have a pharmacare strategy in this country. A lot of people we know go to hospital and they get their medicine, but when they come out, if that medicine costs them $15,000 a year many of them cannot afford it. What would be the cost to the health care system of incorporating those absolutely necessary treatments via genomics?

Dr. Pierre Meulien: That's a great question. It's exactly the question that we asked the project teams who gave us proposals for the personalized health competition. They had to indicate what the economic rationale was for introducing the genomics-based—whatever in particular it was—in cancer or epilepsy or whatever. What is the economic value to the health system? If they did not have a business case, that proposal went in the bin. We were only going to entertain those that demonstrated economic sustainability value to the health system.

Hon. Hedy Fry: Chair, I think I'm out of time.

What am I looking at here?

The Chair: You're done. Thank you so much.

Now we'll go on to Mr. Lobb.

Mr. Ben Lobb (Huron—Bruce, CPC): Thank you, Chair.

My first question is for Mr. Edwards. I don't know if you mentioned it in your presentation—I might have missed it—but for how long have you been operating the consortium?

Dr. Aled Edwards: It's 10 years now. It's now the largest public-private partnership on the planet in this area of drug discovery.

Mr. Ben Lobb: Very good.

To give an idea to the committee, then, in those 10 years Mr. Meulien mentioned you've developed or discovered 25% of all that's been discovered in that—

Dr. Aled Edwards: In one area, yes.

Mr. Ben Lobb: With that amount of information that you've been able to discover, is there anything tangible you can—

Dr. Aled Edwards: Yes, there's one cool story, as an example.

There's a drug that's called Gleevec. Some cancers are caused when a chromosome breaks and they join together and half of one gene gets fused to half of another and creates like a monster chimera that doesn't know how to stop and it causes the cell to divide and divide. Novartis made a drug that treated CML, chronic myelogenous leukemia, a death sentence, by saying, that's a unique protein in the genome; it doesn't exist in all of us it only exists in the few people where the chromosome is messed up and broken. I wonder if I can make a drug that targets that? And indeed it works. That took six years from here's the molecule to first-in-man treatments in people.

We had another case where we were studying a new protein in another cancer where the same phenomenon happens. It happens in adolescence and they die in six months. We started with Glaxo's help the idea of what happens if we stop half of the protein we have, the ones we worked on? GSK said, guys, here's a patented from Mitsubishi, it's got a start, you should work on this. We collaborated with a guy in Harvard who has treated these patients and in 10 months published the paper with a chemical that cured the cancer in animals and....

Path one, which would have been the path normally followed, is patent that molecule, keep it secret, raise the money, and every step would be legal business, legal trying to grab a buck. We gave that compound away to 250 labs around the world. A guy in New York and a guy in Boston, whom we didn't know, took that compound and said, good gosh, it works not only for this cancer, but for two others. GlaxoSmithKline said, thank you very much. They didn't pay for it, this was all in the open but they said, we've got something internally that we can use that information for and they already did their first experiment in cancer patients. Three years.

So you can monetize time in this industry. Because three years ultimately in a billion-dollar drug is a lot of money and they put $10 million into the consortium and said, hey, guys, work on this. Then our sharing environment, our no-patent environment, made things happen real fast and it was three years as opposed to six.

● (1620)

Mr. Ben Lobb: That's interesting because regardless of the industry or the sector, you always hear of all the different silos that are built creating the lack of collaboration.

Dr. Aled Edwards: Absolutely.

Mr. Ben Lobb: It appears you've maybe come across here with something that's really going to change.

Dr. Aled Edwards: Canada led, I should add.

Mr. Ben Lobb: The next question you mentioned a little bit on, but I'll ask you anyway. You mentioned six years to three years. The technology that you're using to come across these discoveries, how's that changing? Is it developing and improving so instead of taking six years the technology now allows you to do it six months? How is that evolving?

Dr. Aled Edwards: Yes, it's a little bit faster but nine women can't make a baby in one month, right?

Some hon. members: Oh, oh!

Dr. Aled Edwards: Biology takes some time.

The Chair: We could try.

Dr. Aled Edwards: You could try.

The Chair: With all due respect, Doctor, it would take a man to make that kind of statement.

Dr. Aled Edwards: It's actually attributed to my wife.

The Chair: Now you're blaming your wife.

Dr. Aled Edwards: I think it's brilliant.

Technologies are getting faster, but when people get sick it takes a while to see if they're getting better and you need to be careful with toxicology tests. In that six-year period, two years were negotiating between the Dana-Farber Cancer Institute at Harvard and a drug company. They couldn't come to a deal and the guy had to move universities to do the experiment. So from six to three isn't all due to peace, love, sharing, and stuff but a lot is.

I think that in total, if this happens on a mammoth scale, you'll have dramatically decreased cost in time. And because we all share up front, pharma can't say I'm going to sell it to you, the health care system, for $100,000 because I paid for a lot of research on this. You'll say, no, we shared, we have the exact numbers, this only cost you this much. You should see a good argument from single payers to drive the costs of medicines down because we de-risk it for them.

Mr. Ben Lobb: I just have one quick last point then. When you have the compound—I think you mentioned a compound that's ready—you can basically serve that up to any pharmaceutical company around the world and say, good luck.

Dr. Aled Edwards: That's what we did. Two professors made the key discoveries and then what a pharma will do, they won't use ours, they'll just invent another one, which is easy. But we did the key experiment showing if you block this protein, the cancer gets better. Then they say, thank you, we'll compete.

The Chair: You have another minute if you want it.

I have a question if you don't.

Mr. Ben Lobb: Go ahead.

The Chair: Thank you.

This is astounding because this is the prevention of disease. We have a big pie of money that goes out for health care and we have an aging demographic—all the things that you were talking about, Dr. Edwards.

My question to you is: have you had any opposition at all to setting up this framework?

● (1625)

Dr. Aled Edwards: Yes. We hear it from professors. Why would you work down here? The exciting stuff is here from biotechnology companies. Patents are key. I don't understand why you would not want a patent. We get it from some people in pharma, but pharma has now flipped. We have the heads of the global leaders saying this is a great idea. They did it with us once and we said we have another project for you, this CareforAir. They say, "We're there. We love the model." We need to build on it in Canada or we're going to get our asses kicked eventually.

The Chair: What are you going to do? You have this big get-together in July. What are you going to do to convince everybody else?

Dr. Aled Edwards: If we have strong leadership, we shouldn't care what anyone else thinks. We just need to convince a few people who matter. I've convinced the head of R and D at Takeda, the head of R and D at Glaxo, and the head of neuroscience in four companies. Alain Beaudet in CIHR is there. There's going to be a lot of blah, blah, blah, but we have to ignore it because this is a new way of doing stuff. When you disrupt things, things happen.

The Chair: They're going to really disrupt me because I'm going over time. The committee checks all the logging.

Dr. Aled Edwards: I'm the one who keeps talking.

The Chair: The fact of the matter is that this is amazing. I'm so glad that you two came today to this committee.

We'll now go into five-minute committee questions.

Thank you, Mr. Lobb.

Dr. Morin.

[*Translation*]

Mr. Dany Morin (Chicoutimi—Le Fjord, NDP): Thank you very much, Madam Chair.

Let me start by commending you for your questions. They are excellent.

I want to say that I support technological advancements in genomics research. I believe they are key to the future of health care, both in Canada and around the world.

Dr. Meulien, you did not reassure me, however, regarding the problem mentioned by my colleagues, Dr. Fry and Dr. Sellah. They raised the issue of discrimination based on genetic information and the fact that, unlike other developed countries, Canada has no anti-discrimination legislation. I'm glad Dr. Fry talked about private insurers, which you did not discuss. It's a good idea to examine that aspect.

This morning, I met with representatives from a collective of organizations called Neurological Health Charities Canada. They told me just how much discrimination their members can face when they suffer from degenerative neurological conditions. For example, they described discrimination encountered by family members of individuals with Huntington's disease when those family members apply for jobs and attempt to access employer insurance plans.

That kind of review of genomic information could lead to discrimination because not only could the person be denied coverage under a private insurance plan, but the employer could also consider it to be legal. Most people have a private insurance plan to cover various costs that are not paid for under the public system. Someone could be discriminated against for genomic reasons. An employer may not want to hire that person because the employer knows that certain risk factors are inherent to the individual's medical condition, which could end up being very costly for the employer down the road.

You said that a number of people do not agree with you and do not think we are well protected in Canada. You did nothing to reassure me. Can you make a stronger argument than that? Otherwise, I will still have serious reservations.

Dr. Pierre Meulien: All I can say is more or less what I said in response to the first question. The discussion about private insurance is ongoing. So it's important to examine that element closely with the Privy Council, the Office of the Privacy Commissioner of Canada and other appropriate authorities. We'll keep a close eye on those discussions.

I had a sounder argument as far as health and access to—

Mr. Dany Morin: There's no problem in that respect. I understand your position.

Dr. Pierre Meulien: In terms of private insurance, the discussion is still—

Mr. Dany Morin: The same applies to employers as well.

While I still have some time, I'm going to ask you my next question.

You referred to illnesses where genomic advancements could help, type 2 diabetes, for example. Is offering people with type 2 diabetes some miracle pill to help their condition really the most effective and smartest approach to the problem? Shouldn't we instead be focusing on other types of prevention such as exercise, physical activity?

I can see the benefit more in the case of rare diseases. When it comes to type 2 diabetes, however, I get the sense that people will just take their genomic drug, thinking that it will keep their chronic illness in check, even if they eat what they shouldn't and don't exercise. I wonder whether that wouldn't send people the wrong message.

● (1630)

Dr. Pierre Meulien: Using genomic solutions to help with type 2 diabetes does not in any way mean taking a pill.

[*English*]

The use of genome data for complex diseases starts with prevention, for sure. So I think we're never going to.... If we concentrate on treating chronic disease with new medicines and not look after the preventive part, we're going to lose; it's not sustainable.

Mr. Dany Morin: You mentioned that knowing some of the genes linked to diabetes could help have more specific medication.

Dr. Pierre Meulien: No, it could help manage—

Mr. Dany Morin: The overall condition.

Dr. Pierre Meulien: —I'm saying could help manage people on the whole spectrum.

The one thing I did mention in terms of specificity was in the case of epilepsy or cancer when you want to treat somebody but it's not one disease. Any cancer will have multiple types of.... Epilepsy and autism are the same. We need to understand each person as an individual with their molecular profile so if you had a treatment, you could be more specific for sure.

I think you're absolutely right. For a lot of these chronic diseases, I think we should be focusing on prevention and better lifestyle.

The Chair: Thank you so much, Dr. Meulien, and thank you, Dr. Morin.

We'll now go to Ms. Block.

Mrs. Kelly Block (Saskatoon—Rosetown—Biggar, CPC): Thank you very much, Madam Chair, and I want to join my colleagues in thanking you both for being here. It's been very enlightening and somewhat entertaining. I would have to admit I've really appreciated your very down-to-earth approach and your talking about the work you do.

I am familiar with Genome Canada more through Genome Prairie, definitely through the ongoing support you've received from our government. I come from Saskatchewan.

Dr. Meulien, tell me about your relationship with, I think you mentioned, six subsidiaries of Genome Canada, and talk about either how you work with them in terms of collaborating on or coordinating research projects and any relationships Genome Canada has with the private sector, private industry.

Dr. Pierre Meulien: It's not a subsidiary relationship. Genome Canada has a contractual relationship with six regional genome centres from B.C. to Atlantic. The relationship is such that their job contractually, if you like, is to raise money for co-funding because each program we run is a co-funded model. We put in sometimes a half, sometimes a third, and the regional genome centres are responsible for raising that other money, whether that's through their interaction with the province or the regions or other funders. That's one role.

The second role is a monitoring role because all our projects are large scale, milestone-driven, and it's up to the regional genome centres to monitor those projects very carefully to ensure each team is meeting its milestones. We have been known to cancel projects that have not performed.

The third one is because it's large-scale science, they need to organize the teams that are going to compete. It's a very competitive process. To give you an example, 146 pre-applications were looked at for the personalized health competition. Seventeen projects are funded. You can work out the competitive nature of that calculation.

Dr. Aled Edwards: Can I add something? Think about how it was before this genome stuff. We all knew about one or two genes to study and we all studied them. It's as if you're an astronomer and you can see two stars, you study them. But what genomics did was it just went boom, there they all are. We're still studying the two as I showed you before, because we love them. What genomics has enabled us to do is to go into the unknown.

Canada is unique. I travel the world. I spend a lot of my time travelling, obviously. I'm in Mexico listening to a talk on cattle from a Brazilian scientist. He has 20 slides, of which five are from Canada. He says these are Canadian data funded by Genome Canada because this organization, unlike other ways of handing out funds, emboldens scientists to go into the unknown. When you're first, you obviously are in the lead. I didn't even realize how dominant this technology is in cattle breeding. Instead of taking seven years to find out if the meat is okay, you do the genetic tests and it happens faster and cheaper. We're in the lead according to Brazil. I was impressed. The funding of this kind of science is not just genomics and it sounds different, it's culturally different. It enables us to work in areas where no one else on the planet is working. I think that's why it's so important.

● (1635)

The Chair: You still have one more minute.

Mrs. Kelly Block: Go ahead, please.

Dr. Pierre Meulien: Traditionally, our projects have been reaching out to the private sector on particular, specific projects. We would like to move more to look at a program or look at an area in agriculture, for example. We would love to have more of a close connection with the food industry, the meat industry. We have a lot of small projects on food safety. It's a big issue—food traceability, food safety. We have one on E. coli, we have one on listeria. We're also into the bar-coding speciation area and we're looking at horsemeat in beef burgers and stuff like that, which has the attention of the media.

The Chair: Thank you so much.

We'll now go to Mr. Kellway.

Mr. Matthew Kellway (Beaches—East York, NDP): Thank you, Madam Chair.

Thank you very much, gentlemen, for being with us today.

Dr. Meulien, I wanted to pick up on this issue of the implications of prevention from what you're discovering. When you started you talked about a spectrum of diseases. There's the rare disease on one end, and on the other end there are these complex ones that are influenced by environmental circumstances. When we get into the issue of identifying certain diseases that are impacted by environmental conditions, it seems to me there's a whole range of ethical issues that arise out of that. When you're talking about prevention, what kinds of things are you talking about in practical terms when you study this stuff?

Dr. Pierre Meulien: I don't know whether this is true or not, but....

The Chair: Well, you don't have to say it if you're not sure about that.

Dr. Pierre Meulien: No, it's an opinion that I have. I believe that if people have access to their own genome sequence, and it might be obvious that they have some susceptibility in the future to getting some of these chronic diseases—it might be some cancers, they might be prone to Alzheimer's disease or to type 2 diabetes—I believe, with that information, some of them, not all of them, will change their lifestyle to live longer, healthier lives. That to me is a tool for prevention. I'm thinking of it more as behavioural lifestyle changes rather than anything else.

Mr. Matthew Kellway: That, to me, is the interesting implication. It seems to me that when I look at maps of the city—I come from Toronto—you can map out instances of poverty in the city and you can map out instances of type 2 diabetes, and they correlate very highly. The question becomes, how much do people or are people able to control lifestyle? And what responsibility then falls on the rest of us to enable people to change their lifestyle, etc.? Or do we, collectively as a society, say, well, if this is true that one of the social conditions or determinants of diabetes is poverty, then what are the ethical implications of that for the rest of us and how do we govern that? We can't just say you have a problem and you're going to cost our health care system so start eating brown bread instead of white bread, or whatever the case is.

● (1640)

Dr. Pierre Meulien: That is a super question. I think there's a whole host of things, societal issues, that we need a lot of debate around.

Let me give you the example of smoking. I was living in Ireland when Ireland became the first country to ban smoking in the workplace. There was a piece of very strong legislation that was driving a behaviour or lifestyle bit from individuals. I can tell you that when people were talking about what happened in Ireland, they were saying, “Well, we're only going to see the results in lots of years down the road.” No; visits to pulmonary clinics were tracking downwards within six months of the smoking ban.

I believe, when we're talking about nutrition and other things around that, that the responsibility lies also with the food industry and other stakeholders, and I would agree with legislative action here. In the same way that everybody knows that smoking is bad for you, everybody knows that eating a lot of processed food is bad for you. The amounts of salt, sugar, and fat in some of these processed foods are not healthy at all. Everybody knows about them. But I think we need legislation on that.

Mr. Matthew Kellway: I have one more little question.

Dr. Edwards, just very quickly, you're responding to all this genomic information coming out and developing these crystal things —I don't even know what they are—that pharma can take off and develop drugs from.

Dr. Aled Edwards: ...starting points for drugs, after that.

Mr. Matthew Kellway: Okay.

Are you in a position to push that process further down, that drug patent process, to hurry this up, or do you stop at a very natural, obvious kind of place?

Dr. Aled Edwards: We've pushed it from, as Pierre said, the shapes of the human genes, with one company and then three, and now we have nine making an inhibitor of it, which is a proto-drug. That's pushing it a little further. In July there's the discussion at CIHR with the six pharma, pushing it even further.

You can imagine a world where all this discovery stuff is done in the open, pre-competitively, and pharma competes much later, when the risk isn't whether it will work. The risk is a business risk—i.e., whether I can make a better medicine than my competitor.

That will change the whole economics of drug discovery, and should drop—

The Chair: Thank you, Dr. Edwards.

Mr. Brown.

Mr. Patrick Brown (Barrie, CPC): Thank you.

One question I've asked our different panels has been with regard to the federal role in the regulation of medical devices. Obviously medical devices can be a tool in innovation. In your involvement in the medical and scientific community, what has your impression been? Do we have a process in Canada that is slow, or is it something that you think is fair and balanced?

A lot of things in health care obviously are beyond federal control, but in that specific area we do govern. We've had doctors here: last week we had a doctor who said it was fast and efficient, with no problems; two weeks before, we had two doctors who said it was costly and incredibly frustrating.

I want to know what your impressions are, if you've had any involvement with that process.

Dr. Pierre Meulien: As funders, we don't have direct links or experience with the regulatory authorities. It would be companies involved in our projects who would bring something forward to the regulators.

I've heard both stories as well, and I don't really have an opinion.

Dr. Aled Edwards: I think another driver is the fact that we have a small market. If I have a little company and I have a product to sell, I'm not going to bother with Canada first. I'm going to go and do it in America, where the market is huge.

We're really sort of an inconsequential player in the approval process. I don't think much gets approved here, usually, and that's just for business reasons, not for regulatory reasons, etc. I mean, it's just obvious; you have a ginormous market and a little market.

Our regulators in the drug approval stuff tend to be a little more cautious. They tend to be under-resourced compared with those in America. I think we get our medicines fast enough. If you go too fast, it's risky, and if you go too slow, it's risky. We probably have the right balance.

But you have to remember perspective, right? Very few times will Canada be the launch point for one of these technologies, purely because our market is small.

● (1645)

Mr. Patrick Brown: You've mentioned type 2 diabetes a few times in the discussion so far today. We actually had representatives from JDRF, a type 1 diabetes foundation, here about six months ago on a health committee hearing. Have you had any findings on type 1?

Dr. Pierre Meulien: We have funded some projects. I don't know the details.

Mr. Patrick Brown: Their remarks caused me to ask a question to a few witnesses about international collaboration on research. Are we seeing enough collaboration? They mentioned to me that they were making rapid progress on the project they were doing in Hamilton and Waterloo on an artificial pancreas, which was exciting. The same project was happening in Australia and, in that case, they are working together. That was encouraging. Do you see that? Do you see a lot of collaboration internationally?

Dr. Pierre Meulien: We've seen an enormous amount of collaboration in Canada between researchers and internationally. Most of our projects, because of their size, have some international link, sometimes pivotal, sometimes part of a looser consortium, but sometimes absolutely pivotal. Canada's incredibly collaborative, and we're very lucky to have that kind of culture. Absolutely. It's very strong.

Dr. Aled Edwards: It's one of our competitive advantages.

Mr. Patrick Brown: I remember we had the Minister of Health in here. She talked about the work we're doing on Alzheimer's and dementia, and that being an extensive and collaborative study. Obviously it gives it a lot more strength.

I know you've been asked a lot of questions so far on similar topics, but are there any areas that we haven't itemized today where you believe we could do a better job federally in supporting your work?

Dr. Pierre Meulien: Canada has been criticized too much, in my opinion. We do brilliant research. We punch above our weight when it comes to research, but it stays in academia. We need anything we can do to facilitate translation in terms of creating the right clinical infrastructure networks. That is something, and it's not a small topic because it includes information systems and e-health records in the case of health. A lot of different things need to get done. The federal government can certainly do that.

The Chair: Thank you so much, Doctor.

Now welcome to Mr. Boulerice. We're so happy you're here. You're on.

[*Translation*]

Mr. Alexandre Boulerice (Rosemont—La Petite-Patrie, NDP): Thank you very much, Madam Chair. And thank you for that welcome. This is my first time here but hopefully not my last.

Today's presentations by our two witnesses were truly fascinating. Thank you both for being here.

Mr. Edwards, I have to admit I was under the same impression as your mother. I thought that scientists discovered things and that terra incognita was still a driving force in their research. But it's clear from your graph that everyone's at the same party, so to speak.

I fully realize that you are eager for Canada to take bigger risks as far as all those more or less neglected genes go. According to your graph, the United States, China and the European Union are working on the first 50 to 100 most popular genes, and Canada is working on all the rest, all on its own. Isn't that a bit of a heavy load for us to bear on our own?

[*English*]

Dr. Aled Edwards: Not yet. We could occupy.

Mr. Alexandre Boulerice: Oh, okay. It's not a done deal.

[*Translation*]

Mr. Meulien, do you share Mr. Edward's opinion on our lack of initiative and risk taking? What could your organization do to help with that?

● (1650)

Dr. Pierre Meulien: There is no question that Mr. Edwards is giving an accurate depiction of the reality. What can we do? We can be more open to certain studies that don't involve the same series of genes.

It's up to us, as a research-funding organization, to revisit our peer review systems, which could be seen as more cautious. So it's up to us to change things.

We are always revisiting how we approach peer reviews. So I think there are things we can do in that respect.

Mr. Alexandre Boulerice: Indeed, it's quite apparent that things need to be done, especially if we consider what you said at the beginning. We have trouble innovating because we don't understand enough about human biology. If we open up the gate a bit wider, we will increase our chances of finding cures and preventing certain diseases. This overcautious or conservative mentality does affect the health care system and people's lives.

And I hope you will continue to work with that in mind.

[*English*]

Dr. Aled Edwards: The thing is that industry knows it; we know it. Health research budgets aren't going to grow that much, so why not add to it with industry money? We have the carrot with the public funds for industry to spend the money in Canada. “Here are the rules.” We share all the data, and they'll come. They are coming.

I think we can get massive amounts of industry investment from around the world into Canada for this pre-competitive discovery into the *terra incognita*, as you say.

[*Translation*]

Mr. Alexandre Boulerice: I very much like looking at medicine from the P4 standpoint, which includes a preventive and more participatory approach to care. I would say that, ever since the Second World War, our approach to medicine has been much more focused on giving medication after the disease strikes. We talked about diabetes, Alzheimer's and cancer.

What potential do the human genome and genomics research hold for degenerative diseases?

Dr. Pierre Meulien: There is tremendous potential because people are either at risk of developing these types of diseases or they are not. Knowing that information earlier in their lives is important. They don't have to wait until they are 70 years old to understand what's going on. As I see it, that knowledge would enable us to do a much better job of managing our lives. I think there is huge potential in terms of prevention.

Mr. Alexandre Boulerice: How much time do I have left?

[*English*]

The Chair: You have 30 seconds.

[*Translation*]

Mr. Alexandre Boulerice: That's how long I have to ask a question in the House during question period.

Could you quickly tell me whether the Canadian government—

[*English*]

The Chair: Now you have 15 seconds.

[*Translation*]

Mr. Alexandre Boulerice: What more can we do to improve the Canadian model?

[*English*]

Dr. Aled Edwards: I think we should create a pool of funds to fund basic science with industry partnerships and have the money there to attract the billions that pharma wants to spend in academia. They are looking around the world. They want to spend in Harvard, but it's complicated there. In Canada, if we say, “Here are our rules and this is how we do it”, I'm confident we can increase our research in the public, by government, first, with the cash, and then say “industry come”. I think they are ready to do it in Genome Canada.

The Chair: Thank you very much.

Those were very good questions, by the way. Thank you.

We'll now go to Mr. Wilks.

Mr. David Wilks (Kootenay—Columbia, CPC): Thank you, Madam Chair.

I'd like to thank the witnesses for being here.

Mr. Meulien, you said at one of your talks that we are all very different. That would probably explain why my mom was always saying that about me and why I'm an only child.

Mr. Edwards, I enjoyed what you had to say. You talked in my language. I am retired from the RCMP, so I look at everything as good guys and bad guys, or good girls and bad girls.

Let's look at it in that perspective. When I think about the genes, and we have 20,000 of them, I suspect there are some good genes and some bad genes. Am I right, or do we even know?

● (1655)

Dr. Aled Edwards: I would say there are some that, when they are changed, cause disease. They could be bad when they're different. However, with most of them, we don't know what they do.

Mr. David Wilks: We don't know what they do, but we do know that some of them would probably be high profile when they're identified, should they ever be identified.

Dr. Aled Edwards: Exactly.

Mr. David Wilks: I'm going to ask the question that my colleague Mr. Lauzon asked, and that was that I don't understand why they don't go to Dr. Edwards and say, “You are going to explore gene 16386. Here's your money and don't vary off that gene.”

Do we have enough opportunities in Canada to even vary out of the...you say we're in that cluster of 200 or 300 right now. Do we even have the ability to move beyond that?

Dr. Aled Edwards: We have people as smart as any on the planet. We don't have the resources to do it all, but what we can do is effect a culture change in how medicines are discovered. The world will follow, but I want to be first, because the first movers always get the biggest economic rewards and the biggest scientific rewards.

It's about changing the culture of how medicines are discovered. Industry does it and we get a lot of money, and academia does its blue-sky stuff. But when that happened, industry folks were on the same thing and folks in academia were on the same thing, and no medicines are being discovered. We can change the culture. We're not going to discover it all ourselves, obviously.

Mr. David Wilks: I want to refer, Mr. Meulien, to your 2012-17 strategic plan from Genome. There was a section in there on innovation that included the argument that innovation is not always science-based and that research and innovation are distinct enterprises. The example used was that of Apple Corporation, which is recognized as one of the most innovative companies in the United States, despite being ranked 82nd in terms of research and development spending.

Why is it important for Genome Canada to emphasize the difference between research and innovation?

Dr. Pierre Meulien: That's a great question.

Research is all to do with discovering new things, with creating new knowledge. Innovation implies some application. Innovation is something that a lot has been written about in Canadian terms, and we're missing some stuff in the innovation piece, the innovation continuum. We have this great research that gets a bit stuck in our academic institutions, and we don't have enough tools to pull that out into use.

That's what we're trying to do in our own little field of genomics. We're trying to do it not only in human health, but in agriculture and agrifood, in fish and fisheries, and in forestry. We're working with the users of that technology in each of those areas to try to facilitate true innovation. Innovation implies application.

Mr. David Wilks: In your view, how are the two related?

Dr. Pierre Meulien: Well, you can't have innovation without having some new research or something in the pipeline, right? You can apply innovation to knowledge that is existing, of course, but you can also apply it to knowledge that's very new. That's the kind of perfect storm thing: you have a seamless pipeline between new discoveries coming out of academia and we can turn those into use very quickly, using whatever model, the open innovation model or other models.

The Chair: Thank you very much.

This has been an astounding committee meeting. We've sure learned a lot. Thank you.

Now we will go to Dr. Carrie.

Mr. Colin Carrie (Oshawa, CPC): Thank you very much, Madam Chair.

I want to thank the witnesses. I found today very interesting.

Dr. Meulien, you've said that in Canada we have brilliant research and that innovation implies application. We've had a number of different witnesses here basically telling us that in Canada we're the Boy Scouts of the world in a lot of ways. We do some really good primary research, but it's not translating into commercialization here.

I do have concerns if we put in a lot of government money but then don't get the benefits. I was wondering if you could explain for the committee a little bit about how the government has been working with Genome with some partnerships. Can you explain if that is translating into jobs for Canadians?

● (1700)

Dr. Pierre Meulien: Sure. There are a few things that we should mention here.

One of them is that we've already spun out or enhanced 24 young companies from Genome Canada research. These are companies that have benefited from funding early in their lives. It usually started off as academic funding. They then have created new companies. There are 24 of those that have happened. Some of them are now making revenue and hiring highly skilled Canadians. That's just one aspect of it.

The other thing is that we're working with the Government of Canada to create new programs that really facilitate partnerships between academia and industry. We're about to launch one that's called the genomic applications partnership program, which will build new partnerships between academia and the users of the technology, wherever they are.

If they're tree-breeders, or they're in the aquaculture industry, or they're farmers growing crops, or if they're in pharmaceutical or medical devices companies, we want to work with them, and we're building that program together.

Mr. Colin Carrie: I was wondering if we could continue on this stream of questioning, helping to attract private partners. We've also heard when private partners invest in something, they usually vet it and they want to have a higher probability of success.

Could you give us suggestions around the table of how you think the government could encourage more of this happening? I know in your particular line of research it seems to be happening a little more than in others. How could we see that more of this happens?

Dr. Pierre Meulien: I think it's really to do with program design and targeting specific areas. Also, I know the government is very interested in putting more money into venture capital. That's very important. But Canada is a little too much of a risk-averse country. It's a cultural thing. I think we need to take more risk up front with that money. So whether that goes into BDC or other vehicles of venture funding, it needs to be more risky than it has been.

Second, for the genomic applications partnership program, we're going to be working very closely with IRAP, which has a fantastic lens to the industry side that we're certainly not going to recreate. Working with them will build a lot of value. It's not so much to do with structural changes; it's people on the ground, devising new programs and getting people excited about working together across the academia-industry divide. This will make a big difference.

Mr. Colin Carrie: I know there are a few good examples of different incubators where we are trying to get academia, government, and industry together. You mentioned bringing academia into the clinical setting. As we look towards getting this research into personalized medicine at the clinical setting, how would this be better for the health consumer? Do you have any idea of how much money we'd actually save the system? You'd be personalizing treatments for individuals and you wouldn't have all of these by-guess-and-by-golly treatments that sometimes end up making the patient worse.

Dr. Pierre Meulien: I think those are great examples. The examples of adverse drug reactions are key. Here's a phenomenon—90% of it will be genetic. We should have our genotypes. We should have our genomes going to the pharmacy and the pharmacists telling us we shouldn't have this drug because we have this gene that will turn it into something nasty. As I said in my statement, adverse drug reactions cost the Canadian health system $7 billion per year. We know that we can have an impact on that. That's one kind of cost saving.

● (1705)

The Chair: Thank you very much.

Dr. Fry.

Hon. Hedy Fry: Thank you very much, Madam Chair.

I want to follow up on what Dr. Carrie was saying. I think the concept of taking basic research and commercializing it was tried, actually. I checked that with one of the past Industry deputy ministers. We had done that. It was a part of Technology Partnerships Canada, where basic biomedical research was linked with the private sector. It was run by an arm's-length body, and there was a matching of funds. It did work. It was a 10-year project. It was canceled in 2007, which is unfortunate, because it was providing enormous amounts of venture capital. All the private sector wanted to be involved, all the industry wanted to be involved in getting this to the market. That is a model that was proven to be successful over 10 years and can be used again.

I want to go to something very different. Everyone talks about "little Canada" and how we can play a major role. Canada has a distinct advantage in this kind of research in that we are the only country in the world with such a diverse population that has all the information about patients in one insuring body, which is the provincial public administrator. In the United States, you cannot translate that from private industry, because of privacy laws. Here we have a unique ability to do translational research. We should be seizing that, running with it, because it gives us an advantage, not just in whether we're bright or not bright, but because of our population base and our national public health care system.

Dr. Aled Edwards: We should be realistic, though. Medco, a large insurer in the United States, looks after a quantity of people as large as the population of Canada. You hear similar arguments from the U.K. which has a single payer system. Sweden has a system.

So you're right, but it's not head and shoulders above the rest of the world, and we need to be competitive in that area and a whole bunch of other areas if we're going to attract the private sector investment into this area of research. So we're going to be careful.

Dr. Pierre Meulien: I'm more optimistic than he is.

Hon. Hedy Fry: Yes, so am I actually.

Dr. Aled Edwards: On the "optimist-ometer", I'm 11 out of 10. You can't be more optimistic.

Dr. Pierre Meulien: There are other things that are mapping towards attracting some of the translational stuff. You've mentioned some key ones that I believe are very powerful. As well you have this excellent interface between the researchers and the clinicians that we have in Canada.

We can do what is termed research-intensive clinical trials, and we should be able to do those better than anyone in the world. I think that with the single-payer system and the data we have on families—which, by the way, the rare disease group holds in fantastic regard, because we have the best percentage of hit rates, of being able to solve cases for rare disease in the world, because we have all the generational data. We have all the clinical phenotyping. We have all of the genomic data that goes along with that. It's very powerful stuff. It's very difficult for jurisdictions to get all of that right.

So I am more optimistic than he is.

Dr. Aled Edwards: But on this rare disease thing, I phoned six heads of R and D in pharma around the world. I said, "You have to come meet this group". They all came. They're all going to invest because of exactly what you said. So yes, it will make a difference, but we shouldn't be complacent about it, right?

Hon. Hedy Fry: No, no, no. I just think it's an advantage—

Dr. Aled Edwards: Absolutely.

Hon. Hedy Fry: —that doesn't just look at our size as being "little Canada". We have this particular advantage, the ability to do translational research.

You talked a little bit about this ability to mine all that information and then share it. There was a question, and again we're down to unintended consequences. There's such a thing as sharing.

● (1710)

The Chair: There are only 30 seconds to share this.

Hon. Hedy Fry: How do you share for free and become such a good Boy Scout and at the same time get an advantage out of it? Could you give us a quick answer?

Dr. Aled Edwards: The operational thing about sharing is that there are databases you share, and the process of being involved in a collaboration gives you an intellectual edge. Anyone is free to take that intellectual edge and compete, and that's what they do, but the fundamental knowledge is shared so everyone competes on their brains. The pharma believe that by being involved they get to see more, learn more, and compete, but on a level playing field, and they're happy with a level playing field.

The Chair: Thank you for sharing.

Dr. Sellah.

[*Translation*]

Mrs. Djaouida Sellah: Thank you, Madam Chair.

My question is for Dr. Edwards.

You co-authored a paper entitled "New approaches to rewarding pharmaceutical innovation". And in it, you list some of the drawbacks to drug patenting. They include high drug discovery costs, decreased sales revenues and skewed research priorities that favour incremental changes to existing successful drug therapies over the development of therapies for rare diseases. You argued instead in favour of public funding for basic research, clinical trials and royalty or reward-based schemes. Would medically innovative drugs cost people less if public funding were in place?

[*English*]

Dr. Aled Edwards: Absolutely, and we'll be able to quantify that and negotiate with pharma and say we will not pay that because it did not cost you that.

[*Translation*]

Mrs. Djaouida Sellah: That's a nice concise answer. Now for my next question.

What impact might your suggestions have on medical innovation?

[*English*]

Dr. Aled Edwards: If I understand the question, if we fund research more publicly, how is it going to affect innovation?

Mrs. Djaouida Sellah: Yes.

Dr. Aled Edwards: I think if academia is funded publicly, we won't innovate as much as the industries involved do, and hence, I think we need to do it as a partnership where we have the push from academia and the pull from industry in the same partnership. It's not done anywhere in the world. Our project is doing it. I think it's the right balance and the way to discover new medicines faster, and it's perfectly in line with the government's and all parties' willingness to work with the private sector to make discoveries go more quickly into the clinic.

So it's sharing and it's also business sense.

[*Translation*]

Mrs. Djaouida Sellah: Thank you for your answers.

[*English*]

The Chair: Thank you very much.

Now we'll go to shared time with Dr. Carrie and Mr. Lizon, beginning with Dr. Carrie.

Mr. Colin Carrie: Thank you very much, Madam Chair.

Dr. Edwards, we have a lot of experience here handling political studs, but you talked about these research studs. The way our system seems to be set up is that we have an inherent bias. We have a peer-reviewed system. It seems the same group of academics kind of move things around, and they're reviewing all these studies.

Dr. Aled Edwards: It's all over the world. It's not a Canadian problem, right?

Mr. Colin Carrie: I agree with you there. How do we get ourselves out of this situation? Is there something you could advise us around the table?

Dr. Aled Edwards: I honestly think exactly as your colleague to your right said: we need an assault on this. The genome is finite. There are only 20,000 genes. It makes perfect sense. Let's just do it. There's no incentive for professors, but industry can provide that monetary incentive. As the public, we say, “Fantastic—as long as we share”. We can do innovative research by getting the private sector involved, and they'll help push us into the unknown. That's the big difference. No one in the world knows how to do that because every time a pharma comes in, they think, "How are we going to share these imaginary riches that we're going to make?" Then there are lawyers and nothing happens. This model, driven by Canada, is a business-sense model that involves sharing, and it will go into the unknown.

Mr. Colin Carrie: Is there a way that we can incentivize those investments to stay in Canada? Basically any company can take that knowledge and may put the job somewhere else. And we've paid for it.

Dr. Aled Edwards: I think we can incentivize to ensure that the trials get done in Canada, but I'd be wary of messing around with the market system and saying that it has to be here because that won't work. We should be able to compete in our brains and our entrepreneurship. Having the customer come and collaborate with us is always a better way to do business because you understand the customer. That's why we have so many companies around the oil sands. If we can bring the customers to Canada, and they're not here now, we'll have a much more innovative system in drug discovery.

● (1715)

Mr. Wladyslaw Lizon: Thank you very much.

My question is on something I don't know enough about: genetics. Forgive my ignorance, but if you have someone's genetic code and you know some genes are defective or the code shows that person is going to get such and such a disease down the road, would it be possible to improve that code, change that code, or come up with a perfect code for that person? I know it's another utopian idea, probably, but are scientists working on this? If you discover that a person has defective genes, can a code be somehow changed, the genes be replaced? Is this one of the areas people are working on?

Dr. Pierre Meulien: This area is called gene therapy. It's being experimented with in Canada, at a clinical level, for a specific gene, for a one-at-a-time kind of thing. Changing everybody's code at a more multi-genetic level will be hugely challenging. We're not there, but for certain diseases of the eye, for example, there are clinical trials ongoing in Canada. Dogs have been cured of blindness through this gene therapy.

Mr. Wladyslaw Lizon: Therefore, I can assume that if we did the work on those 20,000 genes and had all the information and all the correlation between the genes, it would be possible down the road.

Dr. Pierre Meulien: Yes. Once again, for multi-genetic things, it's very tricky because for the eye, when it works, you can inject the gene into certain tissues in the eye. To change every gene, in everyone's body, in every cell in everybody's body.... That's very tricky.

Mr. Wladyslaw Lizon: Thank you.

The Chair: Actually, that's reassuring in a sense.

Dr. Fry, you have another chance.

Hon. Hedy Fry: Thank you

I was just saying we talk about genetic engineering, let's talk about genomic engineering. You're creating whole new human beings out of ones who are not deemed to be healthy enough. It's science fiction stuff.

Everything you're talking about is really important. The question is, where do we go from here in Canada? Dr. Edwards has talked about and set up this group that we're talking about, but I believe that Canada can do more, as a federal government, in terms of helping with that private-public academic partnership after the tripartite thing, in which we take academia working with not just pharma but with all parts of industry to be able to create the sort of commercialization of a product or of something new. I know when this was done about six or eight years ago the total amount that was there, private and public contributions, became about $10 billion. If you wanted to build this again, do you think this is enough to really kick-start a major trend in Canada of getting back up to where it used to be in terms of R and D in the G-8, which was number one? Now we've fallen to number seven again.

The point is, how do we move forward with that? What are the real implementation steps? Let us imagine you were the government. Take a risk here. What would you do?

Dr. Aled Edwards: I agree with the statement before that industry doesn't spend money willy-nilly and they do due diligence before they spend. So if we lower the bars to public matching of industry funds, provided it's for the public good and in a pretty competitive way, if we created a pool of funds where every professor had a hunting licence to go out to a company and say, “You give me $10 million for the University of Alberta, and the government will match it, and it has to be shared among everybody”, if entrepreneurial professors had that opportunity to go out to the business world and say, “Come to Canada, spend your money here, the Canadian government will match it with very little peer review in nine months, and we'll wait”, I think we can be nimble and get a hell of a lot of private sector funding. We have excellent organizations that know how to administer this, but the fewer rules to matching with industry, the more industry-relevant research we've done, the more inward investment we'll get, in my opinion, in all sectors, not just health.

● (1720)

Hon. Hedy Fry: In agriculture, etc.—

Dr. Aled Edwards: Absolutely...oil and gas, environment.

Hon. Hedy Fry: Yes, it's all of that.

How much time do I have?

The Chair: You have about a minute and a half.

Hon. Hedy Fry: I'm going to come back to a question I asked earlier on. You said there was one criteria set that said, what is this going to cost and what is the public benefit cost for changing the way we deal with health care? I am still very concerned that it might cost more than traditional ways of treating disease. It could cost more in terms of dollars and cents, not in terms of long-term health care. What kinds of costs would you see as we replace traditional ways of treatment and move into this new type of treatment? Has any kind of cost-benefit analysis been done at all?

Dr. Pierre Meulien: Yes. These are being done by health economists. In fact, we have insisted that each project in the personalized health competition has integrated into the project team a professional health economist to do that work. There are a lot of studies. It's very different whether you're talking about neurodegenerative disease or cancer. It will be very much case by case, but all of those studies are done.

I'm convinced that we will see a very clear demonstration of real value to the health system. If we can't demonstrate it for a particular topic, we won't do it. I don't think the health system can afford to just bring stuff on where we're not absolutely sure there will be value. We will start with the kinds of no-brainer things and then we will adjust going forward, and as soon as we see 10 different demonstrations of this value, then the payer, the health authorities, will begin to pull this technology more proactively.

The Chair: Thank you very much, Dr. Fry.

Hon. Hedy Fry: I just wanted to ask if we could share the list of those health economists because we're doing a study on—

The Chair: Oh, could you share that and send it to the clerk, Dr. Edwards, and then we'll distribute it?

Dr. Aled Edwards: I can, for sure.

The Chair: Thank you, Dr. Fry, for your good questions.

They've given me a question because it's our slot now, so I have full time.

Thank you so much to my side of the committee for doing that. We're all on the same side, but my side of the House, I should say.

We have 20,000 genes, you told us today. You told us that scientists fondle their problems, meaning that they fondle all the specialized genes that they love to be competitive with, so you have only a very small part of that picture, right? Now you've put in an infrastructure that seems to me to be very exciting, and it seems to spread out a lot of things.

I've heard you talk about two variables today: prevention and stopping certain diseases based on genetic makeup. You mentioned two cancers, type 2 diabetes, neurological disease to some extent. Having said that, with this infrastructure you have a huge problem-solving dilemma in some respects. We're all very excited about what we've heard today, and I've loved to hear that Canada is on the cutting edge and a leader because I believe we have the smartest people in the world here, and it's been greatly underrated. But Canada is taking this leadership, and thanks to you people for doing that.

I love your idea about industry being a partner because that's reality. We have an aging demographic and we can't keep up, no matter what anybody says. There's not enough money in any government pot under any party for any reason to keep up with everything we need to keep up with, so we're thinking outside the box. This particular study emphasizes thinking outside the box. That's why we're doing technological innovation.

Having said that right here today, could you tell me what the first emphasis of your work is? Is it prevention or is it curing diseases or do you have a 50-50 split? Can you do that, based on the fact that you can't be all things to all people, can you, doctor, right? So could you please share with the committee where your major spotlight is, your major focus.

● (1725)

Dr. Pierre Meulien: The process we went through to choose some of the projects—because you're totally right, we can't do everything—is that we allowed projects that were across the spectrum from prevention, early detection, treatment. We didn't say we're going to focus here, we're going to focus there. We took all comers. In terms of the evaluation criteria, where we did say the bar will be extremely high...you get buy-in from health authorities, from the clinicians. With the economic rationale, we will base our choice of projects on not only the great science and clinical need, but on that as well. So we haven't said we're only going to concentrate on cancer or neurodegenerative work. We've taken the best possible elements, the best possible demonstrations from any field, that are really focused on being able to deliver some value to the health system in the relatively short term.

The Chair: Thank you.

I'm going to go to Dr. Edwards because I'm running out of time.

Dr. Edwards, is there any program or initiative that is going to build your field of dreams and be able to pass on the entrepreneurial spirit to other scientists who are traditionally fondling the problems, as you put it, because you're so truthful and it's so real. Very brilliant, wonderful people are not reaching their full potential because they don't think outside the box. Are you putting something in play that will help that?

Dr. Aled Edwards: I don't think scientists are inherently risk-averse. I think that the system in place to enable them to go into the unknown works against innovation.

The Chair: I think so too.

Dr. Aled Edwards: I think that if the government in Canada wanted to attract the foreign pharma investment to help knowledge, it could create some sort of program through CIHR or Genome Canada where it says this is money for matching, there are hardly any barriers to funding. If industry funds in our universities and it's knowledge generation, we're there matching and a magnet.

I was just thinking of what it's akin to. Let's pretend the Prairies has oil all over and everyone is in Leduc putting in their thing and all the stuff in Boston is making a better rig to get more oil out of Leduc. If you just go out on your own and, let's say, go to Saskatchewan and you'll be the first one there, but we're all racing after that one little oil patch and there's a whole world out there. If you partner in the funding, pharma will go with us and we'll get investment. They don't need to own it they just want to know where the oil is out there and they'll take care of the rest thank you.

The Chair: I thank you very much. We've only had two witnesses today. You've been one of the most dynamic groups that we've had. We've had amazing witnesses come to this committee, but really this has been very stimulating and the time has just raced by.

I want to thank you for coming. I want to thank the committee for all their very good questions.

With that I will adjourn.