Medicines of the future: A pharmaceutical time capsule

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I really pleased to be here this afternoon. Coming back to the university brings back so many memories. As Chris said I used to sit in the exact same seats that you are sitting in now. I'm here today to talk to you about what I'm actually doing in the Pharmaceutical industry at the moment and hopefully I can reach out to as many hearts as possible and change a few minds.

I've named my presentation 'Pharmaceutical Time Capsule' for reasons which I'll explain as we go through the presentation.

I'm currently working at Hospira as a Senior Quality Officer and a trainee Qualified Person. I'll take you through what that is, but before we can go into exactly what I do, I want you to understand what I do is important.

So the road so far. I was an aspiring medical student; I wanted to be a doctor, but that didn't work out too well. It was very challenging, very competitive. When you graduate you think "You know what, I'm just going to get a job, it's going to be easy I've got a 2:1". But it doesn't actually work like that; you have to get some sort of experience and I had no clear goal after graduation.

My career started four months after graduation. I was lucky to get a job at Nova Laboratories in South Wigston. During the three years when I was at University I didn't realise that Leicester had a pharmaceutical company so close. They specialise in sterile products and cancer drugs. I was working as a Quality Assistant for two years, just to get some experience. I got to the point where I had enough experience and thought I needed a new challenge, so I moved to Hospira, which is based in Leamington Spa. It's another cancer pharmaceutical company. I've been working there for just under a year as a Quality Officer. I was promoted to become Senior Quality Officer after three months and I've been given the opportunity to train as a Qualified Person. You might be hearing these titles and wondering "What on earth is a Qualified Person?" I will take you through it at the end of this presentation.

I've called my presentation a time capsule. A time capsule is a container which stores historical information intended for communication with people in the future. So we can say we're the people in the future and we've found four time capsules. So each of these 'time capsules' is a specific year which is associated with the pharmaceutical industry. It's significant in one way or the other. The first is 1868 when the Pharmaceutical Act in the UK was established to regulate poisons such as arsenic and cyanide. Before this time

[1] Aaron moved to Teva Pharmaceuticals in May 2015. In September 2015 Hospira became a wholly owned subsidiary of Pfizer

people could just going into a chemist store and purchase it and no one would know who you are, or why you're buying it and there was no traceability. So that led to people to say we need chemists to register all of these transactions. If you go in a pharmacy today, you go with your prescription from the doctor, and the pharmacist who's giving you the drugs will register your name and knows that you've taken a particular product. That's important because if anything goes wrong we have some sort of traceability.

1906 is capsule number two, which is when the Pure Food and Drug Act was enacted and this was basically to allow legalised drugs such as alcohol, cannabis and morphine to be correctly labelled and with the right contents and dosage. Why is this important? Well if you think about the medicines that you take today, you want to know you're taking the right dosage. You also want to know what's in it because. Before this time people just used to take something without knowing what was in it. Why am I taking 25mg of something when it could be 100mg of another thing? This was important within the pharmaceutical industry but also with other products. Shockingly it was around the same time that Coca-Cola decided to remove cocaine from its ingredients and replace it with caffeine. Before this time no one knows how much cocaine was in Coca Cola but however, the CEO of Coca Cola actually admitted that cocaine may still be found in Coca Cola in this modern day.

Capsule number 3, 1956, was possibly the most significant of all the capsules in the pharmaceutical industry. Thalidomide was a wonder drug which was developed particularly for morning sickness, for pregnant women who were suffering from nausea. It exists as a racemic mixture of two enantiomers, the R form and the S form, but at that time they didn't really know anything about this drug. They just thought it does the job it is intended to do. It was first sold in Germany, then sold in Europe. It achieved good sales and it was actually promoted as a safe drug. Like I said, it was used as a sleeping aid and treatment for vomiting. Then in 1959, reports started to emerge of a link between the pregnant women who were taking Thalidomide and babies born with foetal abnormalities. There was some sort of correlation there so they started to do more informed investigations of why that was. It was only a few years ago that they discovered the S enantiomer is actually teratogenic, which means it was affecting the development of the foetus. More than 10,000 infants were born with malformations of the limbs and you can imagine how many lives this actually ruined because a drug was on the market without enough research being done. No one knew anything about this drug but back at that time everything was easy, you could just make a drug and get it out there.

It was important to establish some sort of analytical testing and that's when the importance of analytical testing was quite significant because they did more clinical trials, had a little bit more knowledge about the drug and discovered that the R isomer is

the one that gives a positive therapeutic response. It is still in use today as an immunosuppressant to fight diseases such as cancer.

Moving on, people started to realise you can't just have drugs on the market because people are actually not being protected and they introduced the Medicines Act in 1968 and this had three particular goals:

- Safety, which means the product has been produced and has been clinically trialled to the right standards, so when it goes in the market people are actually safe.
- The right quality, which means the consistency of the production and the quality of ingredients, of the raw materials which are used should be of the right standard.
- And efficacy which is basically to show your product does what it is intended to do. There's no point in actually having a drug on the market which pretends to do something but actually doesn't achieve its intended goals, it has to be efficient.

That takes us to the present where we think "What could potentially go wrong in the process when you're making a drug?" Well unfortunately everything could go wrong, at any stage. So I'm going to talk about some of the things that could potentially go wrong. Drug manufacturing problems. You could actually have the wrong formulation when making the drug. You could not have enough excipient. Excipient is just the bulk you add to a drug, like lactose, which allow you to digest your drug better. You could actually potentially make a drug which is different to what you intended. So there must be a step along the way to ensure that you can identify that the product you have made either by methods of InfraRed or UV is actually what it is. The biggest problem that people seem to have is contamination. Microbiological contamination pose a threat to any sterile product you manufacture. Organisms like *Pseudomonas* and *Aspergillus* can potentially lead to death or a pyrogenic reaction, which means inducing a fever. As a drug manufacturer you don't want that, you don't want to hear that people have died because of a product you have made. You could also have degradation of active pharmaceutical ingredient, which basically means when your manufacturing a drug you can start with 100% but you'll end up with about 10%. As a consequence you'll not actually have enough of the drug, so it doesn't do its intended job. The storage conditions have to be right because it could change the molecule. It could potentially make it toxic, it could potentially just be a factor in not making the right quality. The type of glass that you use is also vital because the drug could potentially react with the vial that you've stored the drug in. So all of these factors have to be regulated, they have to be monitored at every single step. This is what I do.

Quality Assurance is that area that allows a Good Manufacturing Practice, making sure that every step along the way before the drug gets to you is actually made to the right standards and QA officers are here to protect you, the patient.

I thought about how to describe the role of a Quality Officer but I think that it's quite difficult to say what the role of a Quality Officer is because there's so many things that a Quality Officer does, but in a nut shell I can sort of summarise what a QA Officer does.

So a QA Officer is there to make sure the product is made to the right standards according to the law, because when you manufacture a product, it is actually registered according to a stated specification. So we're there to make sure all of these specifications are met. That includes the analogical testing, microbiology testing, packaging, labelling, and distribution. You're also there to make sure that if there is any mistake you'll rectify those mistakes. If there's anything that affects the product you're there to fix that problem and prevent it from happening again.

So what do you need in order to become a Quality Officer? I've narrowed it down to four requirements:

1. You need a strong understanding of good manufacturing practice.
2. You also need a degree in a scientific subject but other areas can be considered as well.
3. I think you also need a strong ethical background. By that I mean you know what you're doing is important because if anything goes wrong and you still allow the product to go onto the market, you're essentially not being ethical in that perspective.
4. As with any job you need good communication skills.

Being a QA Officer is very rewarding because no two days are the same. You go in the office or you go to the manufacturing site and you see different things every day. You also have an appreciation of the importance of being guardians of patient welfare; you're there to protect patients. You also have a good salary; you can start from about £20,000 a year depending on how much experience you have, but the more experience you get, and if you work for a better company, you may get £30,000 to £40,000 a year.

The Qualified Person is what I'm training for at the moment. They are the most important person in the pharmaceutical industry, equivalent to a judge because they ultimately have the say so in whether or not a drug is going to go on the market, or a drug is going to get rejected. They use their own scientific knowledge and their experience to make a rational decision that ultimately affects the fate of a product. They also manage the quality system, by that I mean they manage all aspects related with the quality of the product and they have a legal duty, they actually have to have a Code of Practice which is legally binding. If anything goes wrong they could potentially go to jail, and that's how important it is. If a patient dies and you cannot justify that you've acted according to the law, then you can potentially go to prison.

If you're ever interested in becoming a Qualified Person you need a degree such as Chemistry or Pharmacy. Other degrees are acceptable; you need to go on the website of

Royal Society of Chemistry to see which degrees are acceptable. You need at least two years' experience in a role with a company with a manufacturing licence. You need to demonstrate that you've actually worked with a company that's making drugs which are on the market. You need to be a member of one of the following; Royal society of Chemistry, Biology or Pharmacy. In addition to that you need to attend a 12 module course by a recognised training provider. You have NSF-DBA and RSSL which work alongside some universities and they study courses such as Pharmaceutical Law, Microbiology, analytical testing, etc. At the end of the course you have to see the viva, kind of like a PhD. In this viva you have one member from each board from the Royal Society of Chemistry, Biology and Pharmacy and they sort of judge you, ask you scenario- type questions to see if you're fit to become a QP and then you can register as a QP.

I do have to say the 12 modules though are quite expensive. Each module costs about £3000 and last for about four days. If you're ever think becoming a QP you have to demonstrate that you have the potential and the determination so that your company can say, "ok, this person is ready to go and become a QP". Unless you're very rich, it's unlikely you'll be able to pay for this course yourself.

What are the benefits of a Qualified Person? As I said before it's extremely rewarding. The excitement of protecting the patient and knowing that you're responsible for their ultimate protection is actually a rewarding thing. I think that if you ever wanted to become a doctor and for some reason that doesn't work out, I think that a QP is equally as important as a doctor. The reason why is because a doctors extremely reliant on the products which are certified by the QP. What this means is that, for example, if a doctor is treating someone and a doctor has diagnosed that you have a problem and has prescribed you medicine that you can be treated with, there's no point a doctor prescribing you medicine which is actually going to kill you. So a QP is equally as important as a doctor. It's financially rewarding, so you're looking at a starting salary of about £60,000 depending on the company you're working for. The more experience you get you're looking at about £100,000 a year. The good thing is that QPs are in demand; they're like gold dust at the moment. The UK is short of QPs. I also forgot to mention that QPs are a requirement in the EU only. In the United States the FDA does not require QPs, so it's only within the EU.

Now we come back to capsule number four because we've gone through three capsules and I'm sorry to say but there's nothing in capsule number four, it's just blank pages. But I thought since we have this capsule we can put our ideas and what we want of medicines of the future. We can put in this capsule at this particular time, what we expect of medicines of the future. Medicines of the future are going to be made by us. They're going to be there not to protect just us but future generations. We're going to

make revolutionary products which have continuous improvement that can change the way that we live, and the way that we survive.

Some of you today will be involved in actually making some of these medicines. I'm just going to talk to you about some of the medicines which have so much potential that you'll be seeing them in the next few years, but as I don't have enough time it will just be one or two.

When I left Nova Laboratories they were working on Fibrocaps. This drug is manufactured from blood plasma. We all know that the blood plasma has clotting factors. When your blood is clotting you have fibrinogen and thrombin at the end of this cascade. So what Nova have done is to separate the two, isolated them and sprayed dry them, which means that they've made them into powder. Then they mix the two into a 1:1 ratio ready for use in a vial. So you might be thinking "what's the point of having this, it's just a powder it doesn't do anything?", but if you get stabbed today or you're in surgery and your bleeding and your blood doesn't clot, a doctor can spray this mixture of fibrinogen and thrombin and immediately, with a little bit of water, the blood clots. I think this is an example of medicine of the future; you'll have soldiers going to Iraq or anywhere where there's a war, where people will be injured and all you have to do is spray to prevent death.

Recently the EU has accepted advanced therapeutic medicinal products such as, stem cells. We all know from your course you've been studying stem cells which differentiate into specialised cells, depending on what you want them to be. They've accepted the use of Holocar which is a treatment for limbal stem cell deficiency, a disease of the eyes. This is the first ever accepted stem cell which is going to be marketed in the EU, so it's going to be available in the next few years on the NHS which is amazing.

Questions

Q: How did you find out about you're first job? What websites did you use?

A: Well I was actually extremely lucky. My girlfriend was still doing her PhD so I decided to stay in Leicester after graduation for a few months and I just picked up a newspaper and they were advertising this job in a pharmaceutical company based in South Wigston, so I just applied. I didn't originally have any intentions of going in that industry I just applied and I was lucky that they accepted me.

As a Quality Assurance officer the job was basically, we would receive raw material into the warehouse and I was involved in taking sample to the laboratory and these samples would get tested for microbiology or analytical testing. Once the tests have been approved to be fine, then the raw material can be taken into production. I was also involved in validation, making sure that the processes are working as they should be.

Q: I was wondering what sort of work experience you needed to get in to your first role?

A: Initially I didn't have any work experience at all, I'd just graduated. But the fact that I graduated in Medical Biochemistry and the fact that I really needed a job was the luck that I had. I am aware that if you want to be a Quality Officer you need, people always say you need experience but how are you going to get experience if no one's willing to give you a chance? I think that sometimes it's all about luck really.

Chris Willmott: So, sometimes it a small company which is a good place to start because they were recruiting locally. You might think Boots or GSK but actually there's a lot of these smaller biotech companies that are scattered around the place in industrial estates that you didn't know were there. So wherever you live in the country there will be some kind of small biotech companies somewhere.

Q: How did you find the transition from being an undergraduate to a professional role? Did you find the transition easy?

A: That was a difficult transition because you get used to sometimes waking up sometimes at ten, you go to a lecture or you can wake up at nine to go to a lecture but sometimes you can even miss lectures, I'm not saying you should do that! But sometime you've been out for the night before and you wake up late or just can't be bothered to make it to the lecture. That happened in my first year, but stopped in the second and third. You have to be basically determined because you can't just have excuses when you're at work. You have to keep coming to work, you have to be consistent, you have to really show you're there for a purpose. Learning all the aspects of the pharmaceutical industry can be quite daunting, but you learn along the way. I think it's all about applying yourself and when you do apply your self-chances will come after you.

Q: You said there are 12 modules to become a QP, what kind of timescale do people take those courses over?

A: The courses can be taken at any time scale but normally people want to achieve becoming a QP after three years of taking the first course because each course lasts maybe four days. It can be pretty intense, the files of stuff you need to know microbiology testing, pharmaceutical law, and so on, it's pretty thick. I think what's important is to have a company which is behind you. Part of that might mean being willing to make you wait as long as you can, so you can gain not just theoretical experience but practical experience. When you do sit the viva the judges on the panel are looking to find that you not just know theoretical experience but you actually have practical experience which you can use as an example in the scenario-type questions that they ask you. You only have six months however, after you finish the course to sit your viva. If you don't pass it you do have the opportunity to take it again though.

Q: Is it really competitive being accepted onto the course?

A: I do have to say again I was extremely lucky because when I left Nova, my manager was training to be a Qualified Person and he'd been in the industry for about ten years. So it's not a course that as soon as you go into the industry you're just going to get lucky and get the course. You need to demonstrate that you have the knowledge and background reading. You think after university all of these lectures, all this studying jus stops after that, you still have to study if you really want to be a QP and you go through practical problems and if you can demonstrate that you can manage these problems. For example, if you find that contamination in one of your vials, how do you demonstrate that this drug is not going to go onto the market or what do you say to say that ok the patients are safe? As long as you have the determination, you can do it.