Next generation vaccines: Transforming the Healthcare landscape

"The battle against drug-resistant superbugs has neglected a key weapon, scientists say: using vaccines to quell the spread of resistance."
Alison Abbott, Nature Magazine, Senior European Correspondent.

"Vaccines have the power not only to save, but also to transform, lives – giving children a chance to grow up healthy, go to school, and improve their life prospects."
Margaret Chan Director-General, WHO. Graeme Wheeler Managing Director, The World Bank Group. Ann M. Veneman Executive Director, UNICEF.

The Company: Anti-infective vaccine platform company with key assets at clinical stage

- ImmunoBiology (ImmBio) is an innovative company, which develops state-of-the-art vaccines using the **ImmBioVax™ vaccine platform technology**
- Capital Structure including leading local and international VC's
- Significant amount of **non-dilutive ($10M) and equity ($12M) of funding raised to date**
- Vaccine platform technology with number of vaccines under development i.e**. meningitis, TB and pneumococcal**
- In 2019 ImmBio signed a **multi-million licensing deal** with the largest Chinese Vaccine Pharma company, **CNBG-Sinopharm**, for co-development and commercialization of ImmBio's pneumococcal vaccine, PnuBioVax in Greater China.

Pneumococcal disease situation: still one of the major killers in the world with antibiotic resistance on the rise

→ **High incidence of the disease and a major cause of mortality in the young and elderly.** 1.6M deaths every year, more than malaria, TB and HIV combined

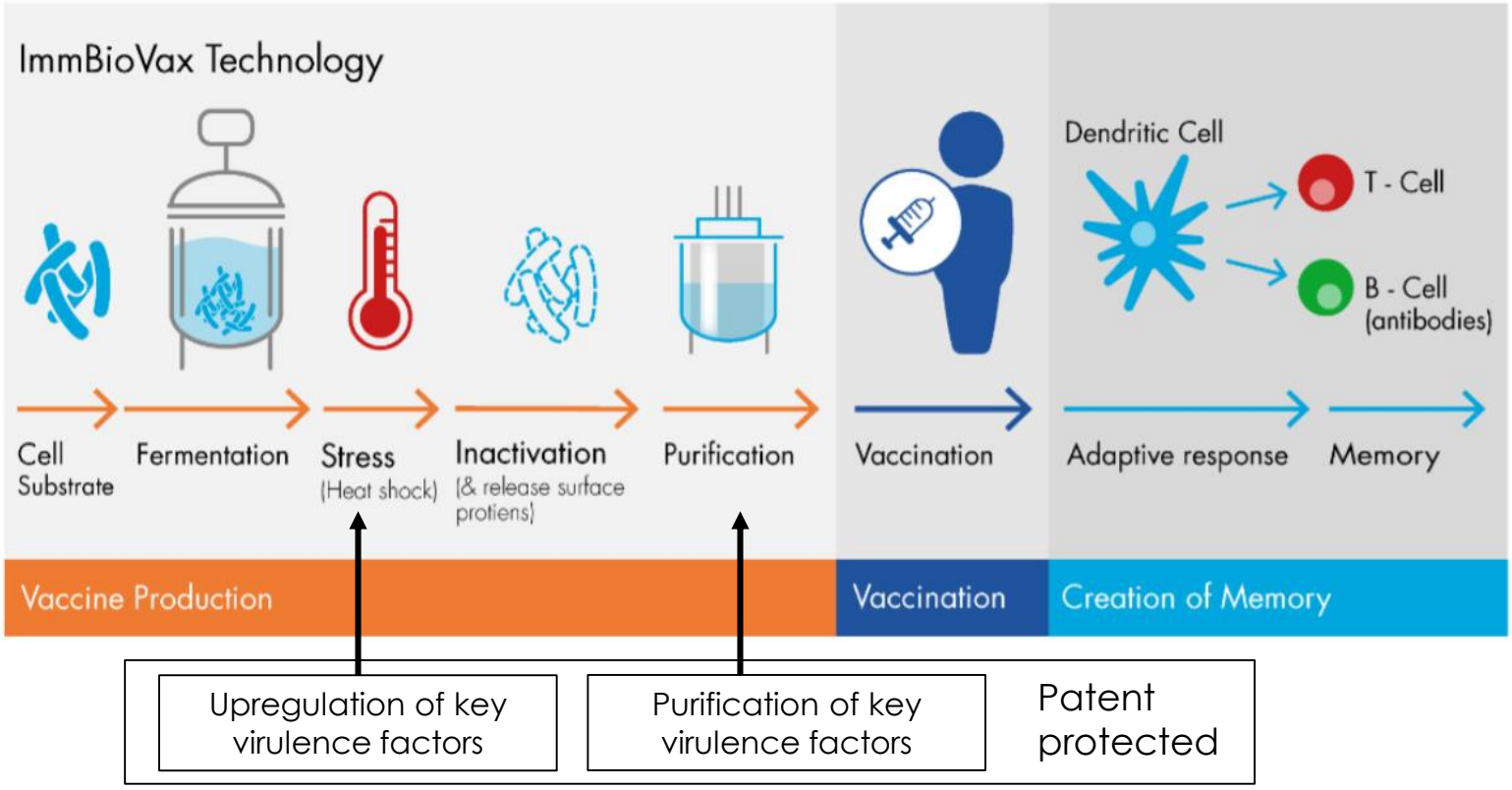
→ **Limited efficacy and coverage of current vaccines**. Increase of serotype replacement with non-vaccine serotypes has decreased the efficacy of current vaccines. There has been an spike of antibiotic resistance of vaccine and non-vaccine serotypes i.e. antibiotic resistance now found in 1 out of 4 cases of all pneumonia

→ **Economic Burden**. In US alone healthcare costs due to pneumonia expected to grow $2.5bn annually. In Europe cost of pneumonia is estimated at €10bn per year.

→ **vaccine accessibility**. High costs of current vaccines means that 70% of the world population that could benefit from the vaccine do not have access to them.

Platform technology: ImmBio's vaccine platform technology, called ImmBioVax™ (IBV) upregulates key virulent proteins to generate an effective natural immune-protection

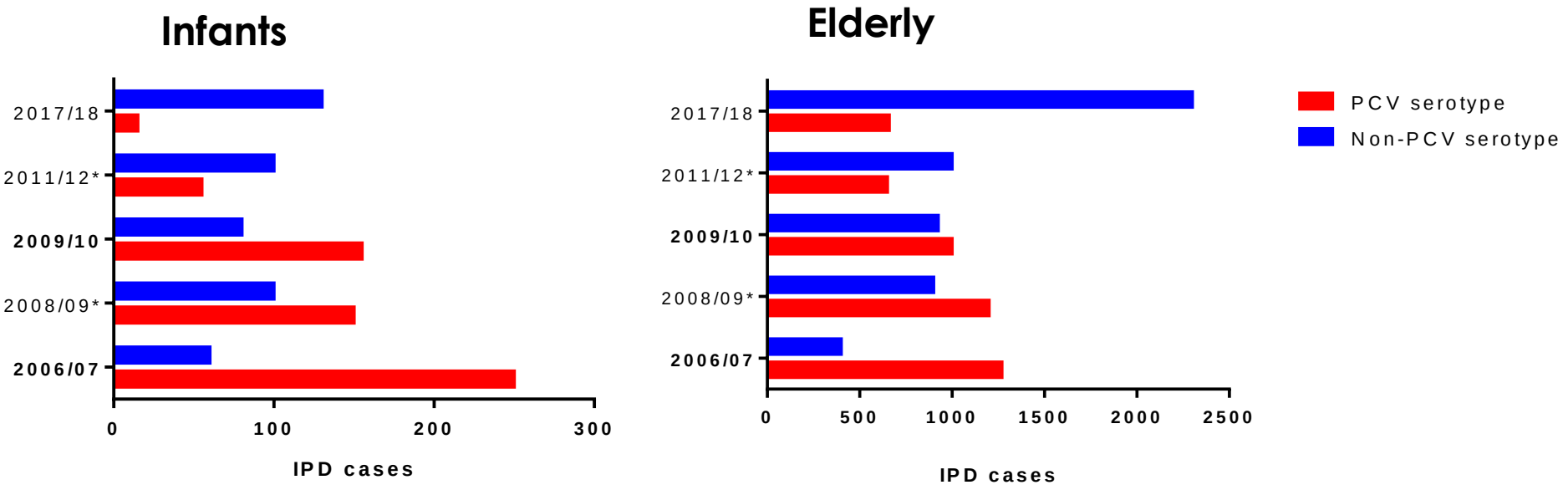
ImmBioVax upregulates key virulent proteins of *S. Pneumoniae* that are purified in an downstream process forming the bases of PnuBioVax™ (PBV). PBV contains a mix of proteins that helps the individual to generate a protective natural immune response.



Serotype replacement: Increase of IPD cases in infants under 2 years and adults over 65 years of age in the UK (2006 – 2018) due to serotypes not covered by current vaccines

Number of reports of Invasive Pneumococcal Disease (IPD) in infants and elderly in England by epidemiological year. Data provided by Public Health England (PHE)

PCV7 was introduced into the infant immunisation program in the UK in 2006/07 and PCV13 in 2009/10.



PCV13 serotypes (PCV7 serotypes in **BOLD**)
1, 3, **4**, 5, 6A, **6B**, 7F, **9V**, **14**, **18C**, 19A, **19F** and **23F**

How has the ‘traditional’ vaccine industry responded to the changes in *Streptococcus pneumoniae* serotype replacement

Vaccine pipeline

Polysaccharide antigen ‘plus’ approach:

- Expanding the scope of current polysaccharide conjugate vaccines by increasing the number of serotypes
- Expanding the breadth of polysaccharide vaccines by the addition of ‘recombinant proteins’
- Modification of the manufacturing process to make ‘polysaccharide conjugates’ more cheaply

Vaccine	Company	Status
PCV15	Merck	in advanced clinical development
PCV20	Pfizer	in clinical development
PCV10 plus ‘recombinant proteins’ ply and PhtD	GSK	on clinical hold
PCVi	CanSinoBIO	in clinical development
MAPs (polysaccharide conjugate with pneumococcal protein)	Astellas	in early clinical development

* Listed vaccines are representative of the industry and do not claim to provide a complete list.

How has the 'innovative' vaccine industry responded to the changes in *Streptococcus pneumoniae* looking for a holistic approach

Vaccine pipeline
Non-Polysaccharide antigens:

- Expanding the scope of current of pneumococcal vaccines by targetting conserved protein and lipoprotein antigens

Vaccine	Company	Status
PnuBioVax™	ImmBio CNBG and LIBP	in clinical development
'Trio' of recombinant proteins	Genocea	on hold
Recombinant pneumococcal protein	CanSinoBIO	in development
Whole cell vaccine (WCV)	PATH	on clinical hold

* Listed vaccines are representative of the industry and do not claim to provide a complete list.

PnuBioVax is the most advanced vaccine in this category

PnuBioVax can delivery serotype independent protection, thereby addressing the global issue of serotype replacement.

Value proposition: PnuBioVax (PBV) is designed to address pneumococcal global healthcare challenges

- → **Value#1: High efficacy.** PnuBioVax (PBV) has diverse modes of action, **mimicking natural, and effective, immune defense against the bacterial infection. PBV targets all pneumococcal bacteria variants and also the emerging ones**. Whilst the efficacy of current vaccines declines over time, it is expected that PBV's efficacy will be able to be maintained for many years, if not to perpetuity. This will be translated into a significant reduction in mortality and burden of the disease worldwide
- → **Value#2: Targeting antibiotic resistance.** PBV multi-protein strategy **allows individuals to select multiple immune targets**, eliminating antibiotic resistance strains. The vaccine produces a **T cell and B cell immune response** that leads to immune cell memory. On actual infection with the bacteria, the immunological memory triggers both T and B cells to recognize and destroy the pathogen
- → **Value#3: Cost-effective.** As a result of low manufacturing costs, set to **be lower than $1 per dose**, PBV will become a **game changer** in the combat of the disease, **reducing the economic and social burden worldwide**
- → **Value#4: Safe**. No significant adverse events were reported during both animal and human trials. In fact, in the **Phase I studies** a total of 36 healthy males and females, aged 18 to 40 years, assessment of safety data concluded that **PBV was safe and well tolerated.**

Management team

John Lambert, *Chairman*

John Lambert has a wealth of experience in the vaccine industry including as President of Chiron Vaccines ahead of its acquisition by Novartis. Prior to Chiron, John was President of Aventis Pasteur MSD, the joint vaccine business of Merck and Sanofi Pasteur in Europe. More recently John has held a number of non-executive positions, including at Acambis, subsequently acquired by Sanofi, and Novavax. He was M&A advisor to Crucell, now bought by J&J.

Dr. Enrique Tabares, *CEO*

Dr. Enrique Tabares has more than 20 years of experience working at different stages of the technology life cycle, having worked in life sciences for Venture Capital, Management Consulting for top Pharma companies and Biomolecular Scientific Research. Dr. Tabares has been a founder and co-founder of a number of ventures. Dr. Tabares has an MSc and PhD in Molecular Biology from Universidad Complutense of Madrid, Spain and MBA from Said Business School, University of Oxford.

Management team cont.

Dr. Camilo Colaco, *CSO, Co-founder*

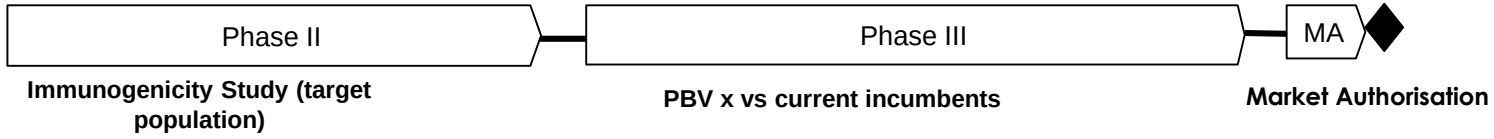
Prior to founding ImmBio, Dr Colaço was Director of Intellectual Property (IP) for the biotechnology company Quadrant Healthcare plc, where he was responsible for development of the IP portfolio that formed the basis of its successful Chapter 20 listing on the London Stock Exchange and subsequent acquisition by Elan. In addition to his industry experience, Dr Colaço has worked in a number of leading institutions, including the University of Cambridge, CALTECH, ICRF and EMBL. He has a 1st Class Hons degree in Biochemistry from the University of London and a PhD from the NIMR, Mill Hill. ImmBio was founded on his seminal proposal of the Central Role of the Dendritic Cell in the integration of Innate and Acquired Immunity.

Dr. Chris Bailey, *Development Director*

Dr. Bailey has extensive experience of vaccine development and scientific and regulatory management related to manufacturing, pre-clinical testing and clinical studies. He was previously responsible for all pre-clinical science (vaccines, rDNA products, gene therapies and small molecules) at Medeva (bought by UCB) and was a key member of the team responsible for the successful pan-European approval of Hepacare, a novel hepatitis B vaccine. He has also held senior scientific roles in a number of biotechnology and pharmaceutical companies. Dr. Bailey has a degree in Biochemistry from the University of Aberdeen and PhD from the University of Cambridge.

Clinical development pathway PBV on ELDERLY

Year 1		Year 2		Year 3		Year 4		Year 5		Year 6	
H1	H2	H1	H2	H1	H2	H1	H2	H1	H2	H1	H2



A single center, randomized, double-blind, placebo-controlled, adaptive design-like study to evaluate the safety and immunogenicity of PBV	A multicentre, double-blind, randomised and controlled trial to assess efficacy of PBV in preventing pneumonia and improving survival in nursing home residents compared to Pneumovax (PPV23).
400 healthy elderly adults age 60-80 years.	1500 healthy elderly adults age 60-80 years. The incidence of pneumococcal pneumonia can be up to 20 times higher in nursing homes compared to non-nursing homes dwellings. .

Strategy for licensure of PnuBioVax for an elderly indication – Phase II

Phase II

A single center, randomized, double-blind, placebo-controlled, adaptive design-like study to evaluate the safety and immunogenicity of two ascending dose levels of PnuBioVax, in healthy elderly adults age 60-80 years.

Primary endpoint: To assess the safety and tolerability profile of PnuBioVax at doses of 200 µg and 500 µg administered by intramuscular (IM) injection on one or two separate occasions per dose group (Days 1 and 29)

400 subjects (100 to choose dose level, 300 subjects to select number of doses at the selected dose level)

Phase III study (Elderly)

A multicentre, double-blind, randomised and controlled trial to assess efficacy of PnuBioVax in preventing pneumonia and improving survival in nursing home residents compared to Pneumovax (PPV23). (1)

The incidence of pneumococcal pneumonia can be up to 20 times higher in nursing homes compared to non-nursing homes i.e. elderly living in private homes in the community. The study can be completed with approx. 1500 subjects.

Note:
By contrast a randomised controlled trial were to be carried out for one year among elderly (≥65) people in the US (incidence 2/1000/year), an estimated 22,300 people would need to be enrolled in each vaccine and comparator group.

1) Based on clinical study conducted in Japan by Maruyama and colleagues and published in BMJ in 2010.

Vaccine pipeline

Other programmes we are looking to progress into the clinic

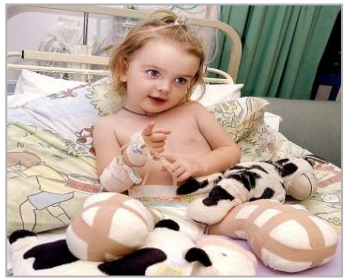
Stage: R&D → Pre-clinical

Licensed out for China market

TB

Endemic + at-risk + traveller ... possible universal

- Boost after BCG protection wanes/failed
- Replace BCG with better/ longer protection.



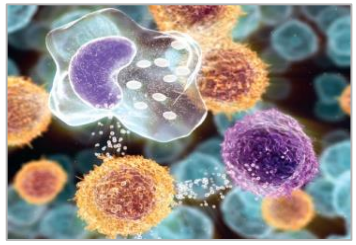
Meningitis

Replace multiple vaccines with single universal

- Men. B cross-strain protection
- Single vaccine against invasive meningococcal disease.

Research

- **H. pylori** – Protection against stomach cancer
- **C. difficile** – protection for drug-resistant "superbug".



Cancer

- Immunotherapy .