AdAlta

next generation protein therapeutics

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IDIOPATHIC PULMONARY FIBROSIS

May 2017

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What is Idiopathic Pulmonary Fibrosis?

Idiopathic pulmonary fibrosis (IPF) belongs to the rare group of serious lung diseases collectively called interstitial lung diseases (ILD) characterised by damage to functional parts of the lung such as the alveolar tissue, bronchioles, bronchi and blood vessels. IPF is the most common of ILDs, representing 50% of all fibrotic lung conditions (see below for patient numbers worldwide).

The term 'idiopathic' literally means 'of no known cause' although it is known that the disease is more common in smokers. IPF results from continued injury to the lung through exposure from irritants, causing dysfunctional inflammation and scarring that does not properly repair but rather produces an environment that promotes persistent and progressive scarring or fibrosis.

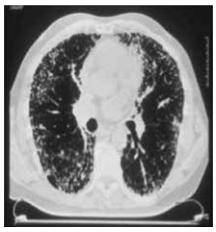
This continual fibrosis results in the thickening of the tissue in the lung, impairing breathing and causing an inefficiency in the amount of oxygen being delivered throughout the body. The amount of scar tissue irreversibly increases over time. The lungs of IPF patients become stiff and shrink in size, with patients typically having half the normal lung volume. IPF is commonly fatal.

Symptoms, Diagnosis and Prognosis

Many patients experience no symptoms during the early stages of IPF. The most common indications are shortness of breath or laboured breathing, a persistent cough and a crackling "Velcro-like" sound when breathing.

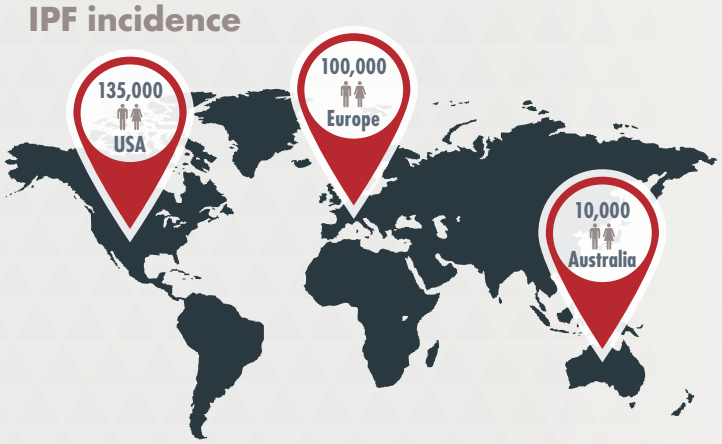
IPF is often challenging to diagnose, with diagnosis of IPF performed by a multi-disciplinary team consisting of respiratory physicians, radiologists and pathologists. The team reviews the patient's clinical data including physical examination, lung function tests, blood tests and appearance of the lung in a CT scan (see figure to the right) before reaching a consensus regarding the diagnosis.

The course of the disease varies greatly, ranging from a lengthy progression over several years to an acute exacerbation, rapid decrease in lung function and death.



CT scan from an IPF patient

IPF incidence



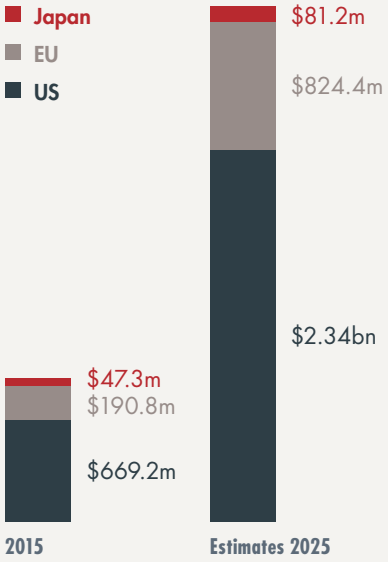
of sufferers die within 2 to 3 years following diagnosis

Current IPF treatments

Pirfenidone — Roche

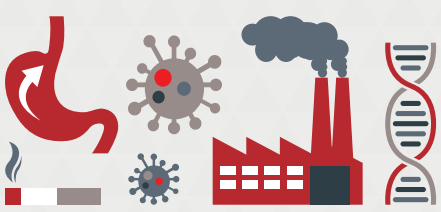
Nintedanib — Boehringer Ingelheim

IPF Therapy Sales (US$)



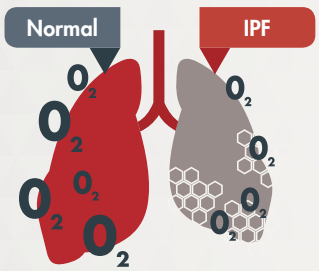
Source: GlobalData IPF Forecast 2016

Causes



The cause is unknown but risk factors may include: smoking, environmental exposures, chronic viral infections, abnormal acid reflux and family history of the disease.

Pathology



Resultant scarring/honeycombing in the lung restricts breathing and oxygen exchange.

Current IPF treatment options

The treatment of IPF was greatly improved in 2014 with the United State's FDA approval of two anti-fibrotic agents – Pirfenidone and Nintedanib. Despite different modes of action, Pirfenidone and Nintedanib are deemed by respiratory clinicians to be equally effective, with both compounds slowing the reduction in lung volume that is characteristic in IPF patients. But these compounds only slow the progression of the disease, they do not act as a cure and cannot halt or reverse the decline in lung function.

Despite their benefits to lung function, Pirfenidone and Nintedanib are also associated with significant side effects. Treatment with Pirfenidone can result in a rash and nausea while also increasing sensitivity to sunlight, making the patient highly prone to sunburn and skin cancer, which is highly relevant in Australia. Nintedanib demonstrated significant gastro-intestinal side effects including nausea and diarrhoea.

Developing new IPF therapies

The world urgently needs improved treatment of IPF. A range of agents are currently being developed to combat IPF, targeting various pathways. But as of April 2017 there were no drugs reported to be in Phase III trials for IPF. Summary data for earlier stage studies/trials are detailed in the table (see right) based on publicly available information.

A novel target

Independent studies (*Moeller et al, American Journal of Respiratory and Critical Care Medicine, Vol 179, 2009*) have shown that chemokine receptor type 4 (CXCR4) positive cells (fibrocytes) can be significantly elevated in IPF patients and are an independent predictor of early mortality. Patients with more than 5% fibrocytes had on average just 7.5 months to live compared to patients with less than 5% fibrocytes who had on average 27 months to live.

AdAlta's unique approach

AdAlta has developed an **i-body** (see box below right for further information) called AD-114. AD-114 has been shown to specifically bind to CXCR4. This data has been peer reviewed and published in the *Journal of Biological Chemistry (June 2016)*.

AD-114 binds to the diseased lung tissue from IPF patients but not to normal lung tissue. Extensive pre-clinical experiments have been performed in the lab (*in vitro*) and in animal models (*in vivo*), showing dramatic positive effects of AD-114. AD-114 has demonstrated both anti-inflammatory and anti-fibrotic activity in animal models.

CXCR4 is a novel disease target pathway in IPF and AD-114 would be a "first in class" drug for treatment for this "orphan disease" indication. Drugs are recognised by industry participants as "first in class" when, for example, they use a new and unique mechanism of action for treating a medical condition.

Orphan diseases affect up to 200,000 Americans and are often fatal, having few or no drug treatment options. Both classifications offer the potential to positively impact speed to approval, in that the majority of these drugs meet an unmet clinical need. AdAlta was granted orphan status for AD-114 in January 2017.

AdAlta's AD-114 represents a UNIQUE pathway not currently addressed by approved drugs or those drug candidates in the clinic.

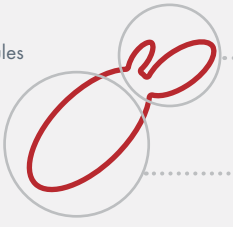
Phase II	
Various Bristol Myers Squibb (NYSE: BMY) candidates	BMS has developed and acquired several compounds for the treatment of IPF including BMS986202, that has recently completed a Phase II study and received orphan drug designation from the FDA, as well as TD-139 acquired from Galecto Biotech and PRM-151 acquired from Promedior, both in Phase II trials.
Fibrogen Inc (NASDAQ: FGEN)	Fibrogen has one product (FG3019) that is currently in a Phase IIb study for the treatment of IPF.
Biogen Inc (NASDAQ: BIIB)	One candidate in Phase II clinical development for IPF, STX100/BG-000111 (acquired in March 2012 from Stromedix).
Sanofi (NYSE: SNY)	Sanofi has commenced a 52-week phase II study of its anti IL-4 and IL-13 product, SAR156597 and the additional product GC1008 is in Phase II.
Various Hoffmann-La Roche (SIX: ROG) candidates	Roche has a Phase II study on-going for anti-IL-13 product Lebrikizumab in patients with IPF, as well as a Phase I study for Vismodegib.
ProMetic Life Sciences Inc (TSE: PLI)	A Phase II trial of the erythropoiesis-stimulating agent PBI-4050 for the treatment of IPF alongside approved therapies, Pirfenidone and Nintedanib is underway.
Kadmon Corp LLC (NYSE: KDMN)	Kadmon initiated a phase II study for KD025 in June 2016 for the treatment of IPF, and are also looking at its application in other fibrotic conditions.
Afimmune	Current lead product DS-102 has completed a first-in-human Phase I study and recently initiated a Phase II study.
Other companies with drugs in Phase II or the intention to commence Phase II studies include:	• Afferent Pharmaceuticals (AF-219) • MediciNova Inc (tipelukast) • Celgene Corporation (CC-90001) • Galapagos (GLPG-1690) • Kasiak Research Pvt Ltd (Refacell-IPF)

Phase I	
GlaxoSmithKline (NYSE: GSK)	GSK has two current products in Phase I development; GSK3008348 and GSK2126458.
Various Teva Pharmaceutical Industries Ltd (NYSE:TEVA) candidates	Teva has acquired a number of drug candidates with multiple mechanisms of action that are now in Phase I clinical development for IPF including MMI-0100 (acquired from Microdose Therapeutics as a pre-clinical asset in June 2013) and SD-560 (acquired from Auspex Pharmaceuticals as part of a larger acquisition in May 2015).
Vicore Pharma	Lead fibrosis candidate C21 has been granted orphan drug designation in Europe and the US and has completed a Phase Ia first-in-human, with Ib planned.
Other companies with drugs in Phase I include:	• Samumed (SM-04646) • ImmuneWorks (IW001) • Pacific Therapeutics (PTL202)

What is an i-body?

An i-body is a unique human protein that combines the advantages of small molecules (for stability) and antibodies (with a high affinity and specificity for treating certain illnesses) in one powerful treatment.

The i-body has a unique long loop that can bind to a diverse range of targets meaning that it has wide applicability across many diseases.



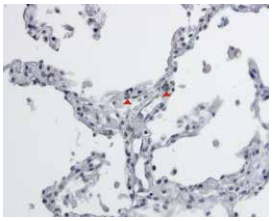
AD-114 makes encouraging progress to the clinic

- ✓ Key data published in the Journal of Biological Chemistry June 2016
- ✓ AD-114 binds more specifically to diseased human IPF tissue than normal lung tissue
- ✓ AD-114 is more effective than existing approved IPF therapies Nintedanib and Pirfenidone
- ✓ In an animal model of IPF, AD-114 significantly reduces key contributors to fibrosis
- ✓ AD-114 was granted US FDA orphan drug status in Janvay 2017
- AdAlta signs manufacturing agreement to scale up production of AD-114
- Toxicology studies to demonstrate safety of i-body AD-114
- First in man Phase I studies

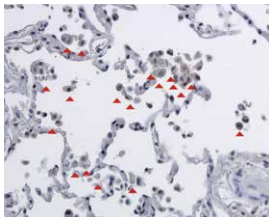
AD-114 demonstrated to bind to CXCR4 with high affinity and specificity.

Images of normal and fibrotic lung

A. Normal lung tissue



B. IPF diseased human lung tissue



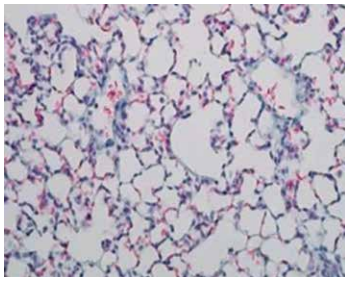
The red arrows left indicate binding of AD-114 to IPF diseased human lung (B) with limited binding to normal lung tissue (A). These studies confirm the significant binding of the i-body to diseased tissue.

***In vitro* Migration Assay Results**

Test Agent	No effect on normal fibroblasts	Inhibition of IPF progressor fibroblasts
i-body AD-114	✓	✓
Nintedanib (Boehringer)	×	✓
Pirfenidone (Roche)	✓	×

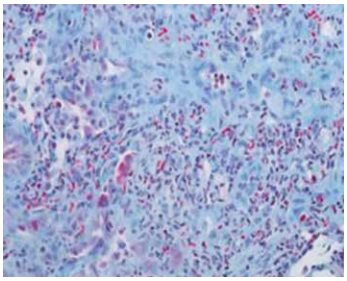
Effect of AD-114 treatment on lung tissue of an IPF mouse model

A. Normal lung tissue



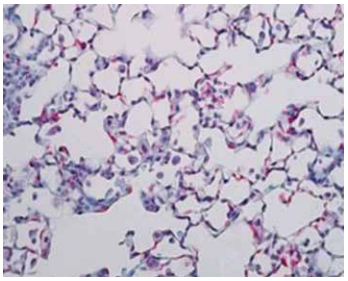
This picture of a normal healthy lung has been stained to show collagen which appears in blue. Compared to Figure B there is little blue staining.

B. IPF diseased lung tissue



This picture shows the mouse lung after treatment with Bleomycin, a toxin that is used to simulate the effects of IPF in this model. The Bleomycin is administered at day 0 and at 21 days post administration the lung tissue collagen content is analysed. The Bleomycin treated mouse lung shows extensive collagen deposition (blue staining) typical of fibrosis.

C. IPF disease lung tissue treated with AD-114



This picture shows the lungs of a mouse given Bleomycin and then treated with AD-114 daily for 21 days. The lungs are now observed to have a similar architecture to that of the normal lung. AD-114 decreased the total collagen content in the lungs demonstrating the anti-fibrotic effect of the i-body in vivo. It shows very little collagen staining similar to the normal lung tissue as in Figure A.

AdAlta exciting collaboration with The Alfred Hospital, Melbourne

TheAlfred

AdAlta has fostered a highly successful collaboration with The Alfred Hospital and the clinical research team led by Dr Glen Westall, an expert in lung fibrosis and IPF. The partnership provides access to specimens from IPF patients. These samples are a valuable resource to understand the influence of both CXCR4 and AD-114 on fibrosis. This research aims to investigate the mechanism and cell types involved in the anti-fibrotic effects observed upon treatment with AD-114 as well evaluating the potential application of AD-114 for the treatment of IPF.

"We are excited to continue working with AdAlta to further understand this complex fibrotic disease and how the Company's novel i-body may play a role in the treatment of IPF, for which there is currently no cure."
Dr Glen Westall, Respiratory Physician at The Alfred hospital.

Dr Glen Westall provides an overview of IPF, current treatments and unmet medical need in the AdAlta Fibrosis Briefing video series available on the AdAlta website www.adalta.com.au.

Further Information

The following resources provide further information on IPF:

Lung Foundation Australia Fact Sheet

http://lungfoundation.com.au/wp-content/uploads/2014/01/Idiopathic-Pulmonary-Fibrosis_FS-Dec15-1.pdf

IPF Registry Information

http://lungfoundation.com.au/patient-support/other-lung-conditions/idiopathic-pulmonary-fibrosis-ipf/

Introduction Video to IPF

https://www.youtube.com/watch?v=1Kyo9Hcyiq0