EDISON

Imugene

In-licensing deal for CF33

In-licensing deal for CF33 oncolytic virus

Pharma & biotech

Imugene has agreed to acquire a worldwide exclusive licence for a highly potent, chimeric oncolytic poxvirus known as CF33. The company proposes to progress CF33 into a Phase I safety study in 2020, including a cohort treated with CF33 in combination with a checkpoint inhibitor. This strategy is similar to that pursued by Viralytics, which was acquired by Merck for A$502m in 2018 after conducting studies of its Cavatak oncolytic virus in combination with Merck's checkpoint inhibitor, Keytruda. The CF33 acquisition strengthens Imugene's immunooncology pipeline, which is currently focused on B-cell vaccines. As the CF33 deal is a related party transaction and therefore contingent on shareholder approval, we maintain our published valuation of A$159m or 4.4 cents per share.

Year end	Revenue (A$m)	PBT* (A$m)	EPS* (c)	DPS (c)	P/E (x)	Yield (%)
06/17	1.2	(2.5)	(0.1)	0.0	N/A	N/A
06/18	1.8	(3.9)	(0.1)	0.0	N/A	N/A
06/19e	2.4	(6.1)	(0.2)	0.0	N/A	N/A
06/20e	3.3	(8.2)	(0.2)	0.0	N/A	N/A

Note: *PBT and EPS are normalised, excluding exceptional items.

CF33: Potent oncolytic virus that targets cancer cells

CF33 is a novel, chimeric oncolytic poxvirus developed at the City of Hope Cancer Center in California, which was deliberately designed to maximise its potency at killing cancer cells. Like other oncolytic viruses in development, CF33 replicates in tumour cells, causing those cells to rupture, as well as triggering the body's immune system to recognise and attack the cancer cells. Imugene proposes to develop CF33 in combination with checkpoint inhibitors (a strategy sometimes described as pushing on the accelerator while releasing the brakes on the immune response).

Shareholder approval required

CF33 is being in-licensed from a company associated with Imugene's chairman, Paul Hopper. Approval will be sought at a shareholder meeting (date TBD).

HER-Vaxx Phase II started, PD1-Vaxx Phase I planned

Imugene initiated a randomised Phase II study of its HER-Vaxx B cell vaccine in HER2-positive gastric cancer in March. It also aims to initiate a Phase I study of its PD1-Vaxx PD1 B-cell vaccine in 2020.

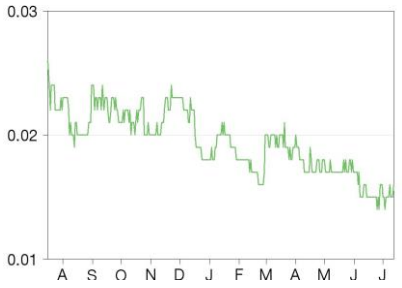
Valuation: Maintained at A$159m or 4.4 cents/share

As the proposed transaction is contingent on shareholder approval, we have not attempted to place a value on the CF33 programme, so for now we maintain our published forecasts and last published valuation of A$159m or 4.4 cents per share. With cash of A$21m at 31 March 2019, Imugene's existing clinical programme is funded beyond our FY20 forecast horizon (not including licensing deal costs or trial expenditure for CF33).

15 July 2019

Price	**A$0.016**
Market cap	**A$58m**
	US$0.76/A$
Net cash (A$m) at 31 March 2019	21.0
Shares in issue	3,609.8m
Free float	69%
Code	IMU
Primary exchange	ASX
Secondary exchange	N/A

Share price performance



%	1m	3m	12m
Abs	(0.0)	(5.9)	(38.4)
Rel (local)	(2.4)	(12.0)	(42.4)
52-week high/low		A$0.03	A$0.01

Business description

Imugene is developing B-cell vaccines that aim to induce polyclonal antibody responses against important cancer targets, as an alternative to monoclonal antibodies. HER-Vaxx is in Phase II in HER2 +ve gastric cancer. Imugene has agreed to in-license CF33, a potent oncolytic virus that attacks and kills cancer cells.

Next events

Shareholder vote on CF33 transaction	TBD
Submit CF33 IND	H120
Initiate CF33 Phase I	2020

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Imugene is a research client of Edison Investment Research Limited

CF33 oncolytic virus licensing deal

Imugene has agreed to acquire a worldwide exclusive licence to the novel, highly potent, oncolytic poxvirus known as CF33, which is poised to enter Phase I clinical trials in 2020.

The CF33 technology was developed at the City of Hope Cancer Center in Los Angeles, California (City of Hope). Imugene has agreed to pay City of Hope licence fees comprising an upfront payment, annual maintenance fees, development and commercial milestone payments, a royalty on net sales and sublicensing fees.

As part of the overall transaction, Imugene has entered an agreement to acquire 100% of the unlisted company, Vaxinia. As Vaxinia's major shareholder is Paul Hopper, Imugene's executive chairman, the deal is a related party transaction that requires shareholder approval at an extraordinary general meeting (date to be set). The Vaxinia acquisition includes an upfront cash payment of A$462,500 and the issue of Imugene shares valued at A$1.6m. The Vaxinia shareholders will also be eligible for equity payments on the achievement of development milestones including granting of the Investigational New Drug (IND) by the US FDA, dosing the first patient in a Phase I clinical trial and the Phase I trial demonstrating safety.

The proposed clinical development strategy for CF33 (combination therapy with immune checkpoint inhibitors) is similar to that pursued by Viralytics, which led to its acquisition by Merck for A$502m, announced in February 2018. While the transaction gives Imugene a foothold in a space that has attracted a lot of pharma interest, it is also an area where there are a large number of competing products in development. Therefore, we suspect that Imugene will need to demonstrate superior efficacy in the clinic in order to attract a pharma partner.

Overview of CF33

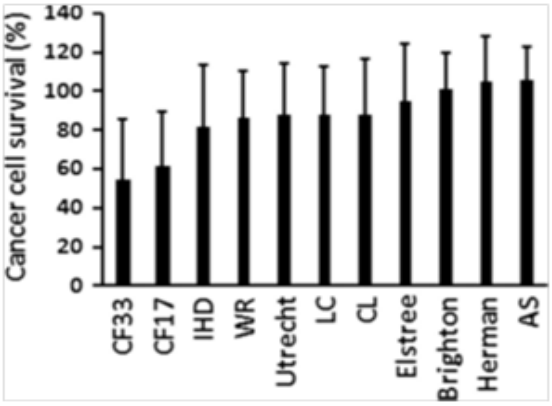
Oncolytic viruses aim to infect and kill cancer cells. A large number of oncolytic virus candidates have been developed and tested over the past 30 years; while they have been shown to be safe, their efficacy to date has been modest.

In an attempt to improve on this modest efficacy, CF33 was developed through a process that aimed to maximise its potency against cancer cells while at the same time maintaining adequate safety. CF33 has been shown in preclinical studies to selectively target and destroy tumour cells without affecting healthy cells.

CF33 was created by researchers at the City of Hope by infecting a cell line with six different strains of the vaccinia virus (widely used in smallpox vaccines) plus raccoonpox, rabbitpox and cowpox viruses. The presence of the nine different virus strains in the cells at the same time allowed the genes from the different strains to be rearranged by homologous recombination to form novel chimeric daughter viruses that contained different combinations of genes from the parental virus strains. One hundred different chimeric viruses were purified and tested for potency against a panel of cancer cell lines. CF33 was the most potent of the 100 chimeric viruses tested.

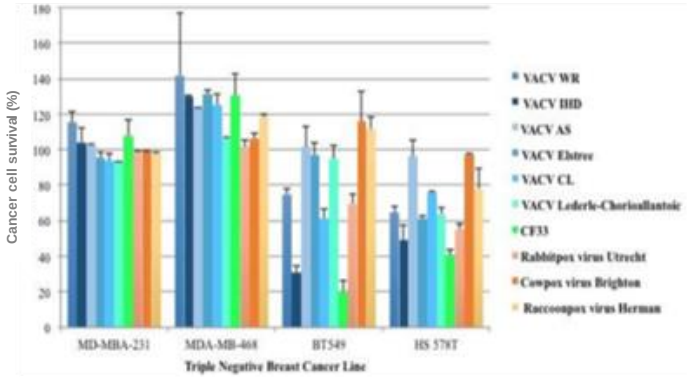
Exhibit 1 shows that CF33 was more potent than each of the parental virus strains when compared across a panel of 54 solid tumour cell lines. Exhibit 2 shows the individual results from a subset of the panel, comprising four triple-negative breast cancer (TNBC) cell lines. Exhibit 2 shows that whereas none of the viruses was effective against the first two cell lines at the dose tested, CF33 (bright green bar) was more effective than any of the parental viruses against the BT549 and HS578T cell lines.

Exhibit 1: CF33 showed superior cancer cell killing compared to parental viruses in a panel of 54 solid cancer cell lines



Source: O'Leary et al. J Transl Med (2018) 16:110. Note: CF17 is a second chimeric pox virus that was created at the same time as CF33; the other columns represent the nine parental viruses/virus strains.

Exhibit 2: CF33 killed more TNBC cells than the parental viruses in high-throughput screen



Source: Choi et al Surgery 163 (2018) 336–342. Notes: bright green bar=CF33; none of the viruses were effective against the first two cell lines at the dose tested (MD-MBA-231 and MD-MB-468). CF33 was more effective than any of the parental viruses against BT549 and HS578T cell lines. VACV= parental vaccinia virus strains.

While the rationale behind the design of CF33 is the belief that the higher potency will give it an efficacy advantage in the clinic, the strategy has a number of other advantages. These include the fact that the new chimeric virus has generated fresh intellectual property (patent application filed) and that the lower number of virus particles needed to infect tumour cells will reduce the cost of manufacturing each dose of virus used to treat patients.

Like other vaccinia-based oncolytic viruses in development, CF33 has had its cancer selectivity enhanced through the inactivation of the thymidine kinase (TK) gene. The inactivation of TK increases tumour selectivity and improves safety, as it means that the virus can only replicate in rapidly dividing cells (such as tumour cells) which have a large pool of available nucleotides, including thymidine. Preclinical studies have shown that inactivating the TK gene does not affect the growth and cytotoxic potential of CF33 in cancer cells.

In addition, CF33 has been engineered to express the human sodium iodide symporter (hNIS) gene. hNIS is a cell surface protein that transports iodine into the thyroid gland for thyroid hormone synthesis. When expressed in tumour cells, hNIS transports radioactive iodine (^{131}I) or rhenium (^{188}Re) into the cell for tumour imaging or therapy.

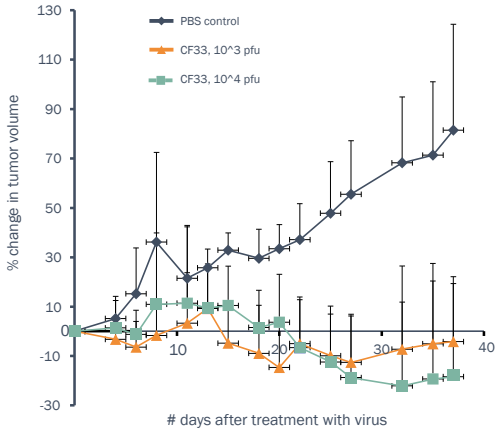
CF33 is effective in a range of animal models of cancer

CF33 has shown promising efficacy in a range of mouse models of cancer. Exhibits 3 to 5 show that CF33 was able to either shrink tumours or arrest the growth of both injected and non-injected tumours, when administered by either intratumoural or intravenous injection. The studies shown in Exhibits 3 to 5 were carried out in standard xenograft models of breast, pancreatic and colorectal cancers, in which human cancer cell lines were injected into immunocompromised 'nude' mice, which do not reject the transplanted human cells.

Exhibit 8, on page 7, shows that CF33 is also effective at low doses in an animal model of lung cancer.

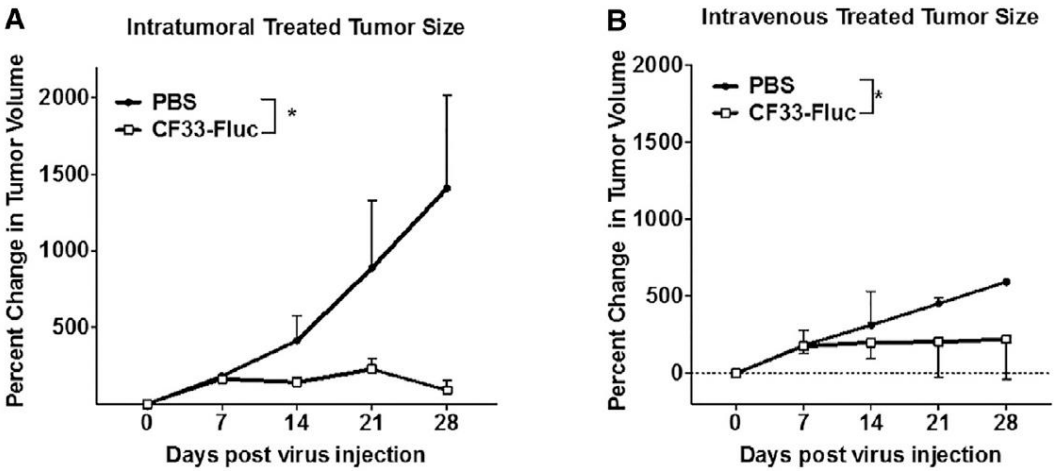
Some of the preclinical studies were conducted using CF33 virus that has been modified to express the firefly luciferase gene. Firefly luciferase is an enzyme that produces a bioluminescent light signal in the presence of an appropriate substrate. The light signal allows real-time imaging of CF33-infected tissue in live animals. The modified virus is known as CF33-Fluc.

Exhibit 3: Injection of as few as 1,000 CF33 virus particles caused tumour shrinkage in TNBC model



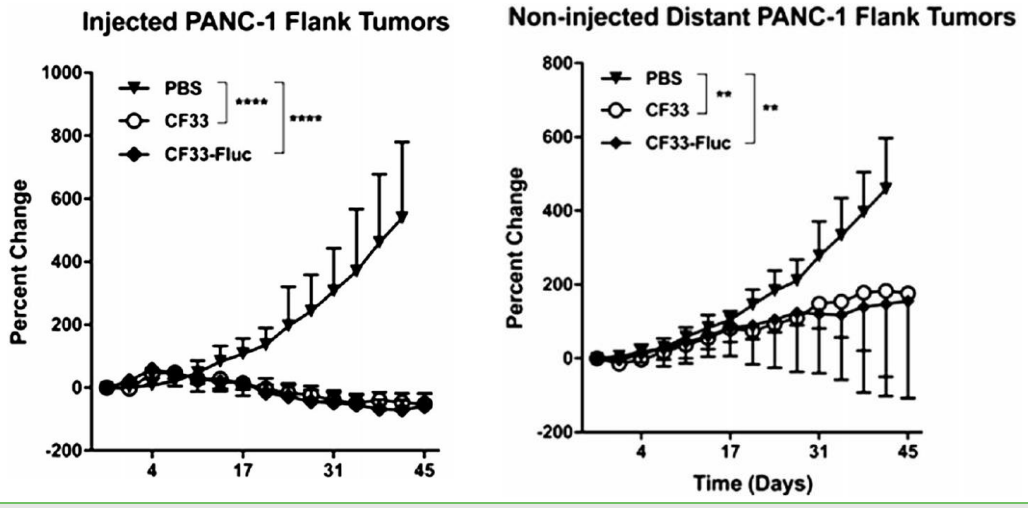
Source: Imugene, based on data presented in Choi et al Surgery 163 (2018) 336–342

Exhibit 4: CF33 arrested colorectal cancer tumour growth after intratumoural or intravenous injection in mouse model



Source: O'Leary et al. Molecular Therapy: Oncolytics Vol. 9 June 2018

Exhibit 5: Intratumoural injection of CF33 caused injected pancreatic cancer tumours to shrink and inhibited growth of non-injected tumours in mouse model



Source: O'Leary et al. J Transl Med (2018) 16:110

Abscopal effect: CF33 causes shrinkage in uninjected tumours

The abscopal effect refers to a phenomenon in the treatment of metastatic cancer whereby shrinkage of untreated tumours occurs following the localised treatment of distant tumours by methods such as radiation therapy or intratumoural injection. Instances of abscopal effects have been reported for other oncolytic viruses, including for Viralytics' Cavatak.[1]

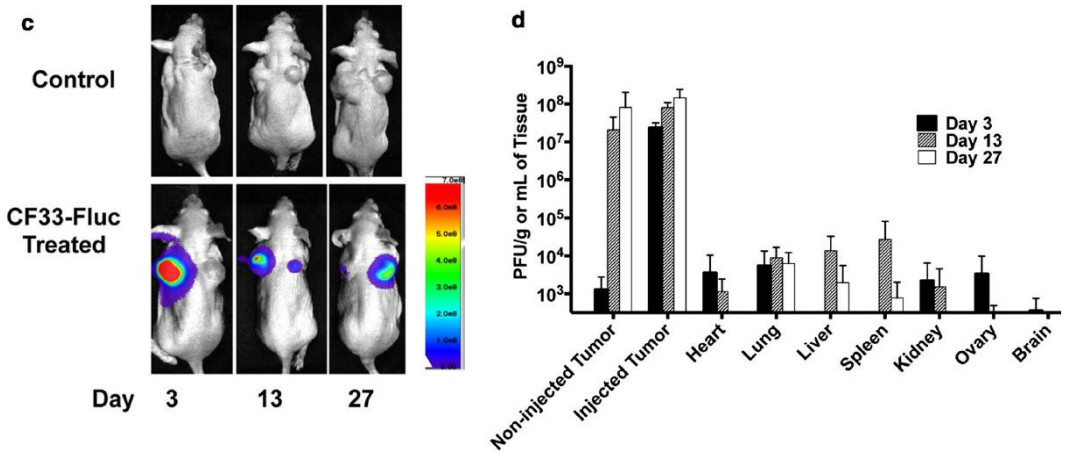
Published reports of preclinical studies conducted with CF33 data show a number of examples of the virus spreading to non-injected tumours and causing tumour shrinkage, in human cancer cells implanted in immunocompromised 'nude' mouse models. Exhibit 6 shows an example of this in a pancreatic cancer model.[2]

Athymic nude mice are used in these studies because they have impaired immune systems and do not reject the transplanted human cell lines. The impaired immune system also means that it is easier for virus to spread in nude mice than it is in animals with intact immune systems. Therefore, it is important to note that Imugene's slide presentation on the CF33 deal states that it has preclinical data showing regression of tumours that did not have viral spread (ie presumably due to an adaptive immune response), and increased infiltration of both injected and uninjected tumours by CD8+ T cells and other immune cells.

Furthermore, cells infected by poxviruses such as vaccinia secrete two forms of virus, an extracellular enveloped virus (EEV) form, which is surrounded by a host-derived membrane and is largely invisible to the host's immune system, which makes it easier to spread within the body.

These two factors may enable CF33 to generate abscopal responses in clinical studies in cancer patients.

Exhibit 6: CF33 carrying luciferase reporter gene illustrates viral spread to non-injected pancreatic cancer tumour in immunocompromised mouse model



Source: O'Leary et al. J Transl Med (2018) 16:110. Note: (c) CF33-Fluc is the CF33 chimeric virus engineered to express firefly luciferase to enable real time imaging of CF33-infected tissue. The injected pancreatic cancer tumour is shown on the left hand side of each image – over the course of 27 days the injected tumour regresses and the non-injected tumour (shown on the RHS of the mouse) becomes infected with CF33-Fluc and expresses high levels of luciferase activity. (d) CF33-Fluc virus counts were at least 10,000-fold higher in tumour tissue than other organs. This study was conducted in immunocompromised 'nude' mice.

1 Fountzilas et al. Oncotarget, 2017, Vol. 8, (No. 60), pp: 102617–102639

2 O'Leary et al. J Transl Med (2018) 16:110.

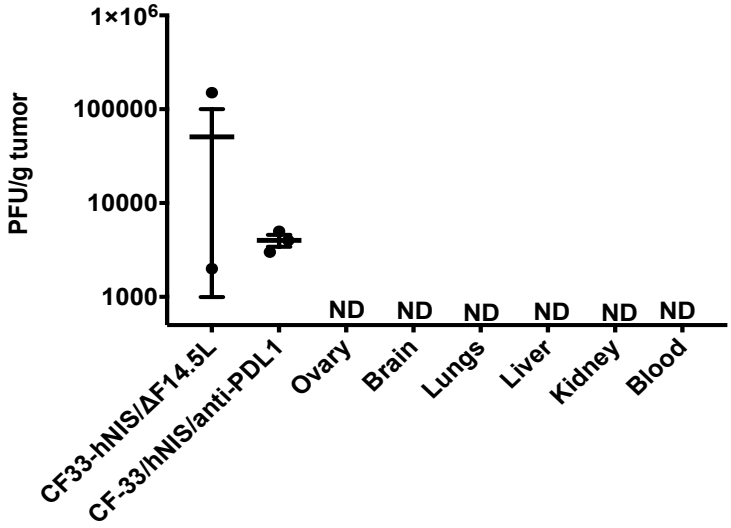
CF33 safety examined in an immunocompetent mouse model

The safety of vaccinia virus, which contributes the majority of the CF33 genome, has been confirmed over a long period of time via its use as a smallpox vaccine. However, given that CF33 also contains components of the cowpox, rabbitpox and raccoonpox viruses, less is known about the safety characteristics of the chimeric virus.

To date, more than 500 mice have been treated with derivatives of CF33. More than 50 mice have been treated with doses of up to 10 million infectious virus particles (pfu), both intravenously and intratumourally, without any sign of toxicity. Exhibit 7 shows that when immunocompetent mice were injected intratumourally with 10m pfu of two different CF33 derivatives, no virus was detected in any other organ seven days after the injection, whereas virus was detected in the tumour.

Furthermore, as the chart labelled (d) in Exhibit 6, above, shows, in the immunocompromised nude mice tumour model, CF33 virus counts were at least 10,000 fold higher in tumour tissue than other organs. This shows that CF33 is highly selective for replicating in tumour cells rather than in normal tissue.

Exhibit 7: In immunocompetent mice, CF33 virus derivatives were undetectable in any other organ seven days after intratumoural injection



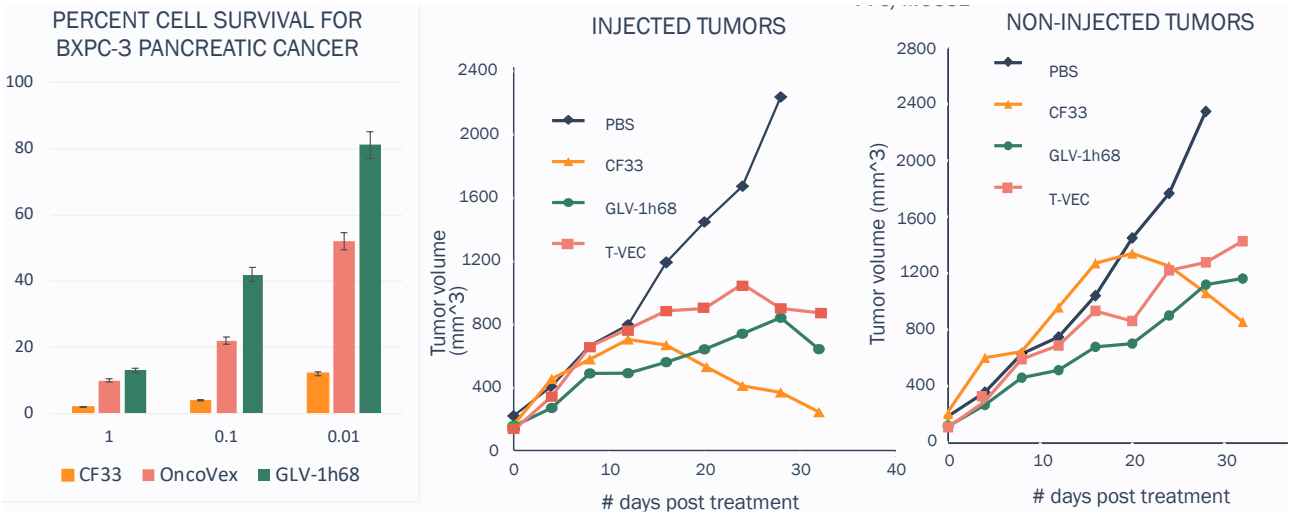
Source: Imugene. Note: Immunocompetent BALB/c mice were injected with 10m pfu intratumourally into a single tumour in the mammary fat pad.

CF33 beats Amgen and Genelux viruses in lung cancer model

The potency of CF33 was compared to that of Amgen's marketed oncolytic virus, Imlygic (T-vec) and a vaccinia-based virus that is in clinical development, GLV-1h68 (GL-ONC1, Genelux) that could be potential competitors to CF33. The study in cancer cell lines showed that CF33 was two to three orders of magnitude more potent than the other two viruses. That is, a 100-fold to 1,000-fold lower dose of CF33 virus particles was required to kill tumour cells in culture, compared to the two other oncolytic viruses (Exhibit 8, left hand panel).

CF33 was also tested against T-vec and GL-ONC1 in a mouse mode of lung cancer. The two panels on the right in Exhibit 8 show that an intratumoural injection of CF33 results in greater tumour shrinkage than an injection of either T-vec or GL-ONC1, both in the injected tumour and in a non-injected tumour in the same mouse.

Exhibit 8: CF33 causes more cancer cell killing and tumour shrinkage than the Amgen or Genelux viruses



Source: Imugene. Notes: Left hand panel compares the three oncolytic viruses in a pancreatic cancer cell line; the two panels on the right hand side compare the effect of the three viruses on injected and non-injected tumours in A549 lung cancer xenografts in immunocompromised nude mice that were injected at a dose of 1,000pfu/mouse; OncoVex= T-vec; 1pfu = 1 infectious virus particle (plaque forming unit).

CF33 clinical development plan

Imugene proposes to commence clinical studies of CF33-hNIS in 2020. The plan includes a pre IND (investigational new drug) meeting with the FDA planned for H219, and submission of an IND application in H120 to gain permission from the FDA to conduct the study in the US.

The proposed clinical development plan is to start a US-based Phase I study in lung, TNBC, melanoma, bladder and gastrointestinal cancers in 2020. The proposal is that 15 patients would be treated with intratumoural (IT) CF33 as a single agent at up to three dose levels. A further 15 patients would be treated with IT CF33 in combination with an immune checkpoint inhibitor (ICI, to be selected) at two dose levels, as shown in Exhibit 9. The estimated trial cost is ~A$5m.

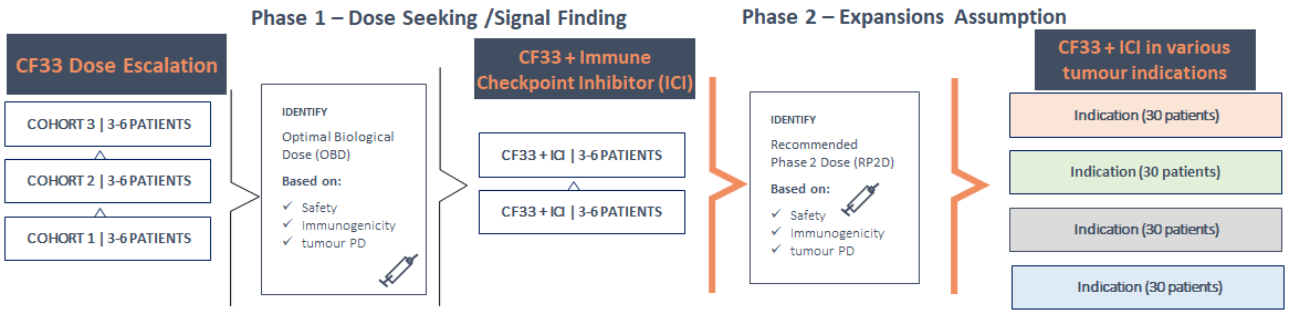
While oncolytic viruses have consistently killed tumour cells in preclinical studies, few have been able to stimulate the immune system to the degree required to generate meaningful clinical benefit. Imugene aims to overcome this challenge by using CF33 in combination with an immune checkpoint inhibitor.

This strategy of combining oncolytic virotherapy with a checkpoint inhibitor is sometimes described as putting your foot on the accelerator (stimulating greater recognition of the tumour by the immune system) at the same time as releasing the brakes (overcoming the immunosuppressive tumour microenvironment by blockade of inhibitory checkpoints).

The intention is for the Phase I study to be followed by a Phase I/II study of CF33 plus an ICI in four tumour types selected from the Phase I cohorts. The plan would be to enrol four cohorts of ~30 patients each, for a total of 100–120 subjects. It is envisaged that the Phase I/II trial could potentially start in H221 (estimated cost A$15-18m).

The manufacture of GMP virus material for the Phase I clinical studies has commenced. An experienced team with prior oncolytic virus development experience at Viralytics will be joining Imugene to guide the development of CF33.

Exhibit 9: Proposed Phase I/II clinical development plan for CF33



Source: Imugene

Patent filed

A patent covering the composition of matter and use of chimeric pox viruses was filed under the international Patent Cooperation Treaty in 2017. If granted, its estimated expiry date would be in late 2037.

Oncolytic vaccinia viruses in context

Researchers have been exploring the utility of modified vaccinia viruses and other poxviruses as oncolytic virus therapies over the past 20 years.[3] Exhibit 10 lists some examples of oncolytic viruses that have been investigated in preclinical studies. Each of these viruses has been modified using recombinant DNA technology to inactivate the thymidine kinase gene and express inserted transgenes to modify the virus properties, in order to improve safety and/or efficacy (in the case of CF33-hNIS, the inserted transgene is hNIS).

Exhibit 10: Selected examples of oncolytic vaccinia viruses used in preclinical studies

Virus name	Inserted transgene	Antitumor activities, especially immunity	Pre-clinical tumour models
Pexa-Vec (JX-594)	GM-CSF	Tumour cell infection and lysis; antitumor immune response; tumour vascular disruption	Liver and other cancers
vvDDGFP	EGFP; (later CD; GM-CSF)	CD11b + cells and CD11b + Ly6G+ cells (dendritic cells and neutrophils)	Breast, colon, and ovarian cancer
GLV-1 h68	Renilla luciferase- GFP fusion protein, β-galactosidase, β-glucuronidase	Immune defence activation via IFN-stimulated genes (STAT-1 and IRF-7), cytokines, chemokines, and innate immune effector function	Breast cancer and other cancer types
VG9- GMCSF	GM-CSF	Antitumor activity and induced tumour-specific immune response	Melanoma
ΔF4LΔJ2R	Luciferase	Durable tumour-antigen specific cytotoxic T-cell response	Bladder cancer
CVV	GFP	Complete regression of liver tumourigenicity and metastasis to the colon	Liver cancer
TG6002 (deVV5-fcu1)	chimeric virus + FCU1	Higher tumour selectivity and more viral replication in cancer cells	Glioblastoma, colorectal, liver, gastric, bladder, oesophageal cancers
CF33-hNIS	chimeric virus + hNIS	Effective at low viral dose; abscopal antitumor effect	Triple negative breast, colorectal, pancreatic, lung cancers

Source: Edison Investment Research, Guo et al 2019[3]

Three vaccinia-based oncolytic viruses are currently undergoing clinical studies (Pexa-Vec, GL-Onc1 and TG6002) and at least one other has previously been tested in Phase I (vvDD-CDSR), as shown in Exhibit 11.

The most advanced of these is Pexa-Vec, which is currently being studied in the Phase III PHOCUS trial in first-line liver cancer. Pexa-Vec is an oncolytic vaccinia virus engineered to express the granulocyte-macrophage colony stimulating factor (GM-CSF) gene to stimulate a systemic anti-tumour immune response.

3 Guo et al. Journal for ImmunoTherapy of Cancer (2019) 7:6. https://doi.org/10.1186/s40425-018-0495-7

PHOCUS is a 600-patient randomised, open-label study comparing overall survival (OS) in patients treated by Pexa-Vec followed by sorafenib (tyrosine kinase inhibitor) versus those treated with sorafenib alone. PHOCUS was initiated in January 2016 and was expected to undergo an interim analysis in H119. According to the record on clinicaltrials.gov (NCT02562755), the trial is expected to complete in December 2020.

In a previous Phase II dose-finding study of Pexa-Vec in liver cancer (n=30; 80% first-line), those receiving high-dose Pexa-Vec (intratumoural delivery) had a median overall survival of 14.1 months compared to 6.7 months for those on a low dose. However, the subsequent Phase IIb TRAVERSE study in second-line liver cancer was terminated early in 2013 as data from the first 80 events showed no evidence of overall survival benefit associated with Pexa-Vec.

Early stage clinical studies are underway of Pexa-Vec combined with the checkpoint inhibitors Nivolumab, Ipilimumab and REGN2810 in liver cancer, kidney cancer and solid tumours, respectively.

Exhibit 3: Oncolytic vaccinia viruses used in clinical studies

Virus name/ sponsor	Inserted transgene	Status	Notes
Pexa-Vec (JX-594)/SillaJen and Transgene	GM-CSF	Pexa-Vec + Nexavar in ongoing global Phase III PHOCUS study in 1L liver cancer. Ongoing Phase I/II Pexa-Vec + nivolumab in liver cancer. Ongoing Phase Ib Pexa-Vec + REGN2810 (anti-PD1) in kidney cancer. Ongoing Phase I Pexa-Vec + ipilimumab in solid tumours	Phase III Futility analysis expected Q219; interim data 2020. N=600. Randomised Phase IIb in 2L liver cancer failed (NCT01387555). In prior Phase IIa in 2L liver cancer OS 6.7mth for low dose, 14.1mth for high dose (n=30)
GL-ONC1/Genelux Corporation	luciferase/GFP fusion, beta-galactosidase, beta-glucuronidase	Phase II study in ovarian cancer ongoing (NCT02759588). GL-ONC1 via intraperitoneal infusion alone or in combination with chemotherapy/Avastin	Primary completion expected December 2019. In Ovarian cancer Phase Ib 1/11 partial response, 5/11 stable disease for at least 15 weeks
vvDD-CDSR/SillaJen, University of Pittsburgh	cytosine deaminase (CD), somatostatin receptor (SR)	no ongoing studies	Two Phase I studies in solid tumours conducted (NCT00574977)
TG6002/Transgene	FCU1	Phase I/IIa in glioblastoma; Phase I in colorectal cancer; Phase I ICI combo studies underway with Nivolumab, Ipilimumab and REGN2810	TG6002 combined with oral flucytosine (5-FC). The enzymes encoded by FCU1 convert the prodrug 5-FC to the approved anti-cancer drug 5-FU in infected cells

Source: Edison Investment Research

High deal values in oncolytic virus transactions

Pharma companies have shown considerable interest in oncolytic virus technologies, with a number of significant deals in recent years (Exhibit 12). This has included the acquisition of three oncolytic virus developers by pharma companies in 2018 alone, totalling US$770m (~A$1bn) in upfront payments and a further US$900m (~A$1.2bn) in potential milestone payments. The transactions included Merck's acquisition of ASX-listed Viralytics for US$394m (A$502m) announced in February 2018, primarily for the purpose of studying Cavatak in combination with its checkpoint inhibitor, Keytruda. This was followed by the acquisition of two companies with preclinical oncolytic viruses, first Janssen (J&J) buying BeneVir for US$140m upfront and up to US$900m in potential milestones, and then Boehringer Ingelheim buying out its partner Viratherapeutics for ~US$236m.

The most notable licensing transaction is the December 2016 deal between Bristol-Myers Squibb and the unlisted British biotech PsiOxus for its preclinical armed oncolytic virus NG-348 (US$50m upfront and up to $886m in development, regulatory and sales-based milestones).

While the deals listed in Exhibit 12 demonstrate the high level of interest from pharma companies in oncolytic virus technologies, they also illustrate that it is a highly competitive space. While in the previous section we have discussed in some detail other vaccinia/poxviruses in development, we note that only two of the 15 oncolytic virus deals shown in Exhibit 12 involve vaccinia-based viruses (Transgene and Jennerex). This reflects the fact that several other virus species are also being developed as oncolytic virus therapies and are potential competitors for Imugene. To attract a

Pharma partner, we suspect that Imugene will need to demonstrate that the high potency of CF33 at infecting tumour cells translates into improved efficacy in the clinic.

Exhibit 4: Selected oncolytic virus deals

Date	Source	Buyer	Deal type	Up-front (US$m)	Total deal value (US$m)	Notes
May-19	Transgene	AstraZeneca	Licensing	10	Undisclosed	Five research candidates
Sep-18	Viratherapeutics	Boehringer Ingelheim	Acquisition	236	236	VSV-GP project, preclinical
May-18	BeneVir	Janssen (J&J)	Acquisition	140	1,040	Proprietary T-Stealth Oncolytic Virus Platform
Feb-18	Viralytics	Merck & Co	Acquisition	394	394	Cavatak, Phase II asset
Nov-17	Oncolytics	Adlai Norte	Licensing	5	65	Far East development of Reolysin
Oct-17	Turnstone Biologics	Abbvie	Licensing	Undisclosed	Undisclosed	Ad-MG1-MAGEA3, Phase I/II asset
Dec-16	Ignite Immunotherapy	Pfizer	Acquisition	Undisclosed	Undisclosed	50% stake
Dec-16	Psioxus	Bristol-Myers Squib	Licensing	50	936	NG-348, preclinical asset
Dec-16	Takara Bio	Otsuka	Licensing	Undisclosed	28	Japan rights to HF10
Nov-16	Virttu Biologics	Sorrento	Acquisition	25 (equity)	35	Seprehvir, Phase II asset
Jun-16	Psioxus	Bristol-Myers Squib	Licensing	10	Undisclosed	Enadenotucirev, Phase I collaboration
Jun-15	Oncos	Targovax	Acquisition	Undisclosed	Undisclosed	Structured as a 50/50 merger
Jan-15	Omnis	Astrazeneca	Licensing	Undisclosed	Undisclosed	VSV project, Phase II
Nov-13	Jennerex	Sillajen	Acquisition	100	150	Pexa-Vec, Phase II asset; currently in Phase III
Jan-11	Biovex	Amgen	Acquisition	424	1,000	Imlygic, approved for melanoma in 2015

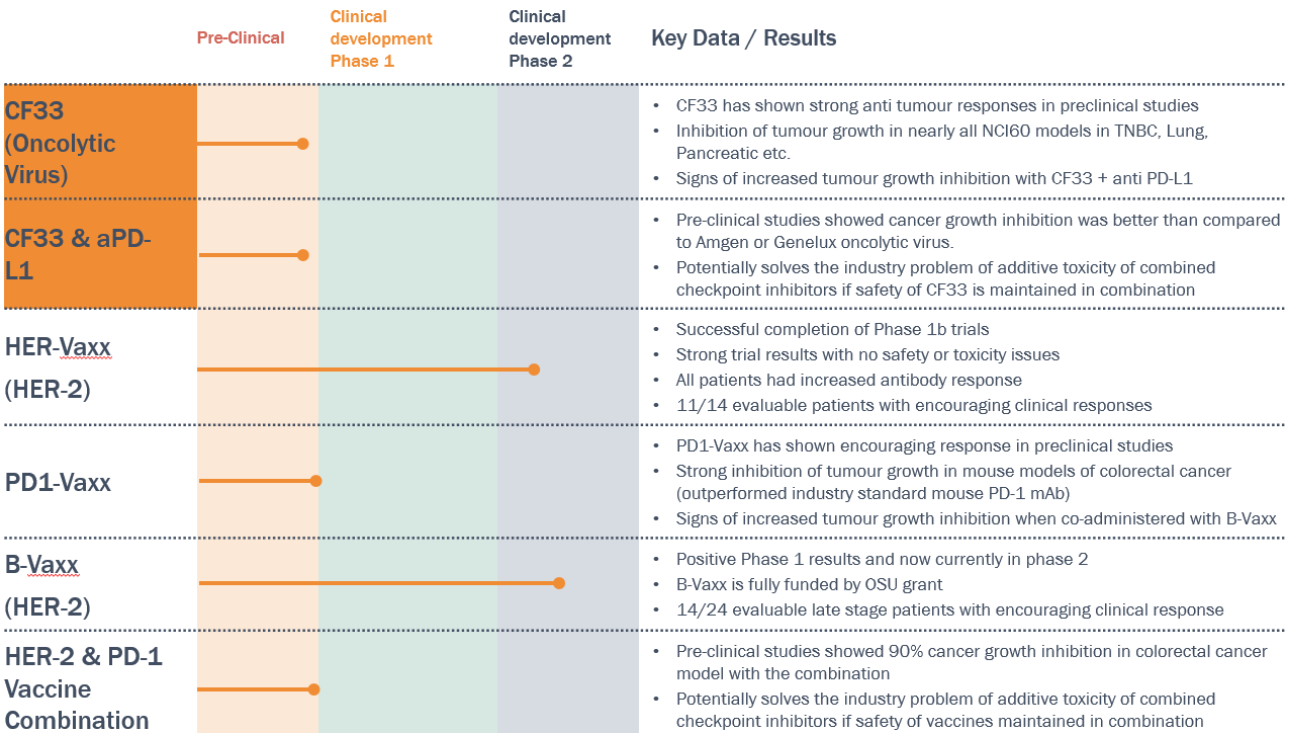
Source: Edison Investment Research, Imugene, Evaluate Vantage, company announcements

CF33 adds to Imugene's immunooncology portfolio

The CF33 licensing deal expands Imugene's portfolio of immunooncology products, which is currently focused on B cell vaccines. It is the company's second significant in-licensing deal in less than 12 months and follows on from the in-licensing of anti-HER2 and anti PD1 B cell vaccines from Ohio State University in June 2018.

If the CF33 licensing deal is approved by shareholders, Imugene's pipeline will comprise the CF33 oncolytic virus plus two anti-HER2 B-cell vaccines that are in Phase II clinical development, plus a preclinical anti-PD1 B cell vaccine, as shown in Exhibit 13.

Exhibit 13: CF33 expands Imugene's anti-cancer immunotherapy pipeline



Source: Imugene

Sensitivities

Imugene is exposed to the same clinical, regulatory and commercialisation risks as all biotech companies. The CF33 licensing deal is subject to shareholder approval and therefore it is not certain that the transaction will proceed, so we leave our forecasts and valuation unchanged for now. If the deal is approved, it remains to be seen whether the increased potency of CF33 in cancer cell lines and animal models will translate into improved efficacy in the clinic. The incorporation of genetic material from other poxviruses into CF33 increases the potential of unexpected safety concerns, compared to the long-established safety record of vaccinia viruses.

Given that there are a lot of other oncolytic viruses at various stages of development, we think it most likely that CF33 will need to demonstrate superior efficacy in clinical studies order to attract a pharma partner. On the other hand, it is possible that the anticipated long patent life for CF33 (if granted) could attract interest from Pharma even if efficacy only matches rather than exceeds that of competing oncolytic virus therapies, in our view. Imugene had A$21.0m cash at the end of March 2019, which should be sufficient to fund operations beyond our FY20 forecast horizon (excluding expenditure related to the CF33 transaction).

Exhibit 12: Financial summary

A$'000s	2016	2017	2018	2019e	2020e
Year end 30 June	AASB	AASB	AASB	AASB	AASB
PROFIT & LOSS					
Sales, royalties, milestones	0	0	0	0	0
Other (includes R&D tax rebate)	1,525	1,164	1,841	2,400	3,280
Revenue	1,525	1,164	1,841	2,400	3,280
R&D expenses	(2,698)	(2,472)	(4,148)	(6,000)	(9,000)
SG&A expenses	(1,596)	(1,232)	(1,718)	(2,326)	(2,396)
Other	0	0	0	0	0
EBITDA	(2,769)	(2,540)	(4,025)	(5,926)	(8,116)
Operating Profit (before GW and except.)	(2,770)	(2,542)	(4,028)	(5,927)	(8,136)
Intangible Amortisation	0	0	0	(282)	(271)
Exceptionals	0	0	0	0	0
Operating Profit	(2,770)	(2,542)	(4,028)	(6,209)	(8,407)
Net Interest	39	35	94	78	201
Profit Before Tax (norm)	(2,731)	(2,507)	(3,934)	(6,131)	(8,206)
Profit Before Tax (reported)	(2,731)	(2,507)	(3,934)	(6,131)	(8,206)
Tax benefit	0	0	0	0	0
Profit After Tax (norm)	(2,731)	(2,507)	(3,934)	(6,131)	(8,206)
Profit After Tax (reported)	(2,731)	(2,507)	(3,934)	(6,131)	(8,206)
Average Number of Shares Outstanding (m)	1,449.0	2,069.0	2,637.9	3,232.4	3,609.8
EPS - normalised (c)	(0.19)	(0.12)	(0.15)	(0.19)	(0.23)
EPS – diluted (c)	(0.19)	(0.12)	(0.15)	(0.19)	(0.23)
Dividend per share (c)	0.0	0.0	0.0	0.0	0.0
BALANCE SHEET					
Fixed Assets	6,623	6,623	7,081	6,898	6,707
Intangible Assets	6,600	6,600	7,057	6,775	6,504
Tangible Assets	3	3	4	103	182
Investments	20	20	20	20	20
Current Assets	2,913	6,054	9,833	22,696	14,682
Stocks	0	0	0	0	0
Debtors	1,313	1,220	1,915	2,474	3,354
Cash	1,583	4,814	7,822	20,126	11,232
Other	18	20	96	96	96
Current Liabilities	(694)	(297)	(438)	(438)	(438)
Creditors	(657)	(232)	(343)	(343)	(343)
Short term borrowings	0	0	0	0	0
Other	(36)	(65)	(96)	(96)	(96)
Long Term Liabilities	(985)	(985)	(1,001)	(1,001)	(1,001)
Long term borrowings	0	0	0	0	0
Other long term liabilities	(985)	(985)	(1,001)	(1,001)	(1,001)
Net Assets	7,857	11,395	15,475	28,156	19,950
CASH FLOW					
Operating Cash Flow	(3,089)	(2,708)	(4,508)	(6,475)	(8,996)
Net Interest	39	35	46	78	201
Tax	0	0	0	0	0
Capex	(71)	(2)	(461)	(100)	(100)
Acquisitions/disposals	0	0	0	0	0
Equity Financing	2,735	5,928	7,930	19,095	0
Dividends	0	0	0	0	0
Other	(20)	(0)	0	(294)	0
Net Cash Flow	(385)	3,253	3,008	12,598	(8,894)
Opening net debt/(cash)	(1,957)	(1,583)	(4,814)	(7,822)	(20,126)
HP finance leases initiated	0	0	0	0	0
Other	11	(21)	0	0	0
Closing net debt/(cash)	(1,583)	(4,814)	(7,822)	(20,126)	(11,232)

Source: Edison Investment Research, Imugene accounts

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