



# BerGenBio

Axl inhibitors for aggressive disease

Corporate Presentation

May 2020

## Forward Looking statements

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# BerGenBio corporate overview



## World leaders in understanding AXL biology

AXL tyrosine kinase mediates aggressive disease: immune evasion, therapy resistance & metastatic cancer, fibrosis and viral infection

Selective AXL inhibitors have the potential to treat many serious unmet medical needs

**Pipeline opportunities in multiple cancers and fibrosis**



## 3 selective AXL inhibitors in clinical development

Bemcentinib (oral once a day pill)  
Tilvestamab (mAb), ADCT601\* (ADC)

Phase II: Monotherapy and combos with, CPI, targeted & chemo

Biomarker correlation, parallel CDx development

Bemcentinib phase II trials:  
**AML** (monotherapy), **AML** (chemo-combo)  
**NSCLC** (KEYTRUDA combo) **COVID19** (mono)



## Resourced to deliver milestones

Listed on Oslo Børs: BGBIO

Clinical trial collaborations with Merck and leading academic centres EU & USA

38 staff at two locations:  
HQ & R&D in Bergen, Norway;  
Clinical Development in Oxford, UK

# Senior Management Team



**Richard S. Godfrey, *Chief Executive Officer***

- Pharmacist / MBA – joined BerGenBio in 2008 as CEO
- Formerly CEO Aenova Inc., USA
- Previously Managing Director DCC Healthcare, earlier Eli Lilly, Reckitt Benckiser, Catalent
- 28 years industry experience, led and managed multiple international drug development and commercialization partnerships



**Prof. James Lorens, *Founder and Chief Scientific Officer***

- Professor University of Bergen Medical School
- 30 years biotech research experience, academic biomedical research positions at Stanford University and University of Bergen
- Former Director Oncology R&D, Rigel Inc. (San Francisco, CA)
- The first to recognize that Axl kinase is an essential mediator of cancer development (EMT)



**Prof. Hani Gabra MD, PhD, *Chief Medical Officer***

- MD Oncologist – joined BerGenBio in 2019
- Former VP Clinical Development Astra Zeneca UK.
- Professor of Medical Oncology at Imperial College London and Honorary Consultant in Medical Oncology at Imperial College Healthcare NHS Trust
- 20 years clinical / cancer biology research at Imperial College London.



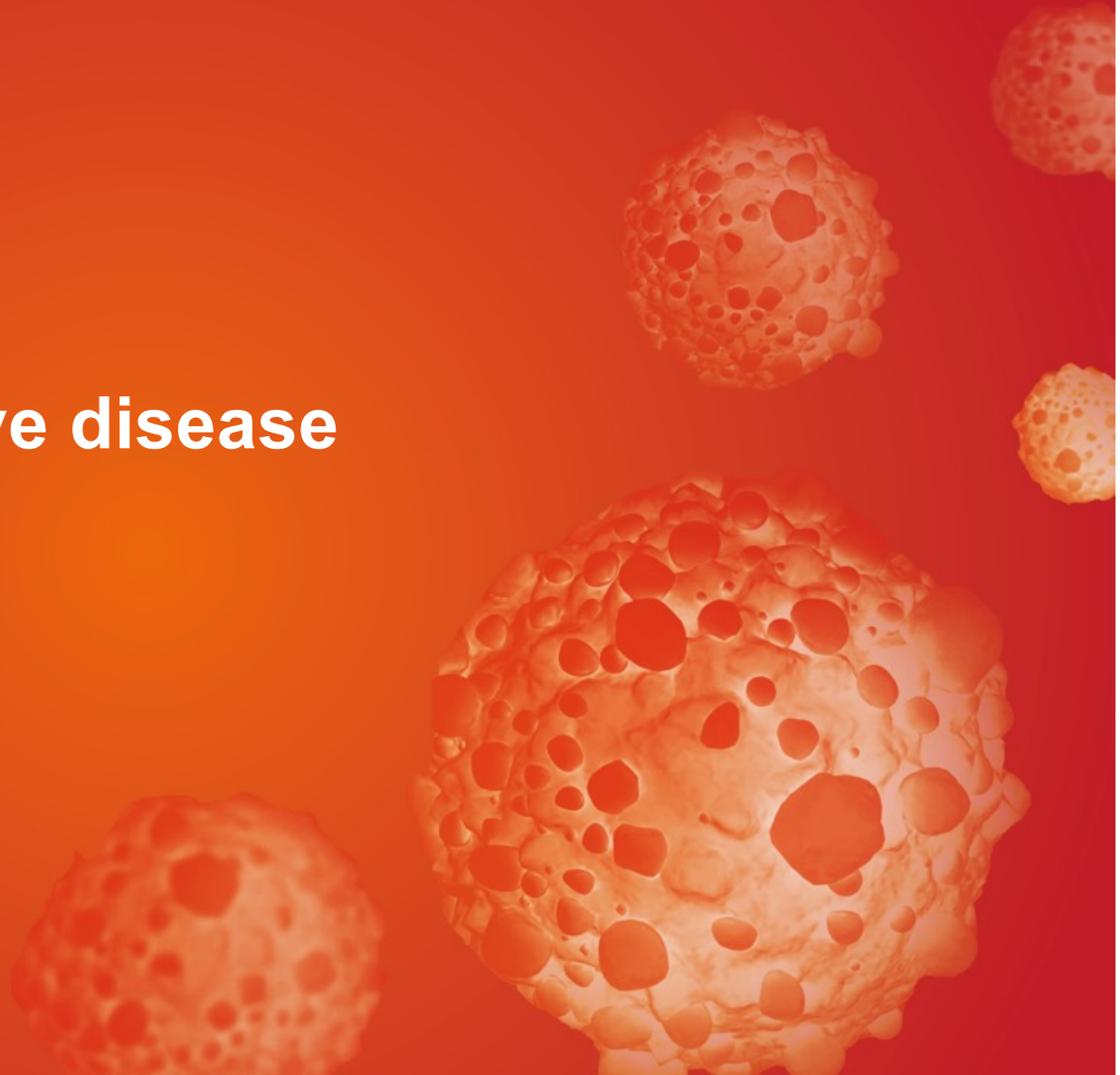
**Rune Skeie, *Chief Financial Officer***

- 20 years of financial management, corporate development, corporate governance and advisory experience across multiple industry sectors. – Joined BerGenBio in 2018
- Previously Executive Director at EY and CFO of REMA Franchise Norge AS, the multinational supermarket business.
- Registered Accountant and a State Authorized Public Auditors

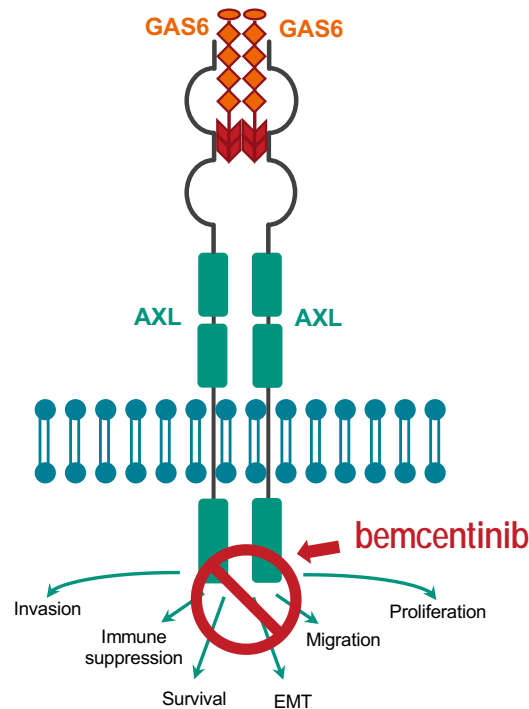
# Recent highlights

Oct 2019	FDA Fast Track designation received for bemcentinib in relapse <u>AML</u>
Nov 2019	Primary & Secondary endpoint of ORR met in Phase II 2L <u>NSCLC</u> (cohort A) in combination with KEYTRUDA® Four-fold improvement over Keytruda monotherapy**
Nov 2019	CDX: Proprietary composite AXL tumor-immune (cAXL) score developed to diagnose patients with clinical benefit Five-fold improvement in ORR and four-fold mPFS improvement for cAXL +ve patients
Dec 2020	Presented preliminary clinical data from Ph II combination trial of bemcentinib and LDAC in <u>AML</u> patients at ASH conference Durable responses reported with long duration
Jan 2020	Met Primary end point of ORR in phase II clinical trial in <u>NSCLC</u> (cohort B) in 2L IO refractory patients Bemcentinib in combination with KEYTRUDA® meets primary end point and progress to stage 2 of the study cohort
May 2020	FPI <u>COVID19</u> rPhII ACCORD trial Uk Govt selected bemcentinib as first experimental compound to enter fully funded seamless platform trial for efficacy and safety

**AXL drives aggressive disease**



# AXL Biology



- AXL a receptor tyrosine kinase that is important for regulating innate immune cells.<sup>1</sup>
- AXL levels are elevated by cellular stress and is strongly associated with inflammatory diseases including cancer and fibrosis.<sup>2</sup>
- It functions as a homeostatic regulator in adult tissues and organ systems that are subject to continuous challenge and renewal throughout life – immune, nervous, vascular and reproductive
- AXL drives cancer progression, immune evasion, and resistance to targeted therapies.<sup>3</sup>
- AXL is a key suppressor of the type I interferon response and is targeted by viruses to block the anti-viral immunity.<sup>4</sup>
- AXL is used by several different enveloped viruses (e.g. Ebola, Zika) to enter cells.<sup>5</sup>
- Bemcentinib potently inhibits SARS-CoV-2 infection of cells.<sup>6</sup>
- A lung cancer patient currently under treatment with bemcentinib who was high risk for COVID19 reported a mild Covid-19 infection.<sup>7</sup>

Very low expression under healthy physiological conditions

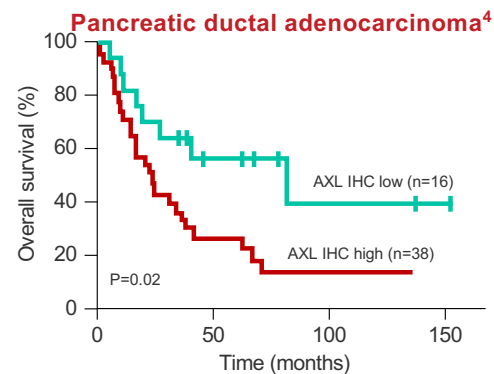
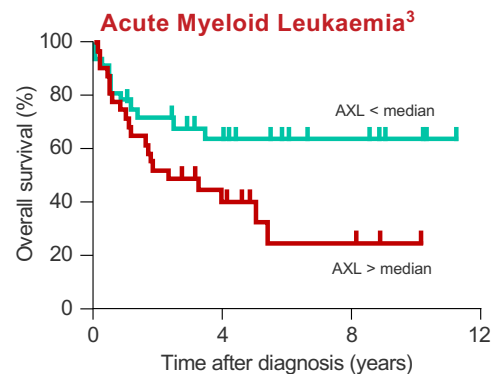
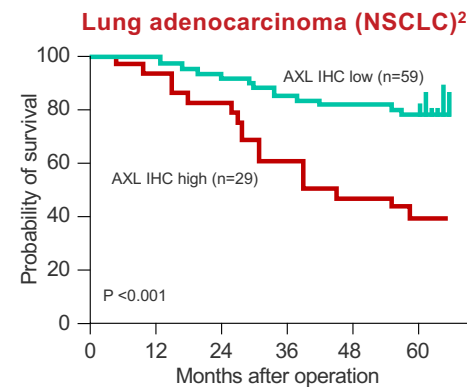
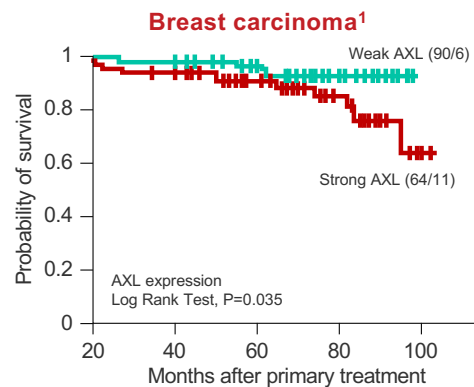
Elevated AXL signaling strongly associated with cancer progression, immune evasion, drug resistance and metastasis

AXL mediates viral entry to cells and dampening of viral immune response

<sup>1</sup>Lemke Cold Spring Harb Perspect Biol 2013; <sup>2</sup>Zagórska Nat Immunol 2014, Ludwig Cancer Res 2018, Espindola, Am J Respir Crit Care Med. 2018;<sup>3</sup>Gay, Br J Cancer 2013; <sup>4</sup>Chen Nat Microbiol 2018; <sup>5</sup>Moller-Tank Virology 2014; <sup>6</sup>W.Maury, unpublished;<sup>7</sup>BerGenBio, unpublished

# AXL is independent negative prognostic factor in a broad variety of cancers

## Strong AXL expression correlates with poor survival rate



## Broad evidence of AXL linked with poor prognosis<sup>5</sup>

Astrocytic brain tumours

Breast cancer

Gallbladder cancer

GI

- Colon cancer
- Oesophageal cancer
- Gastric cancer

Gynaecological

- Ovarian cancer
- Uterine cancer

HCC

HNC

Haematological

- AML
- CLL
- CML

Melanoma

Mesothelioma

NSCLC

Pancreatic cancer

Sarcomas

- Ewing Sarcoma
- Kaposi sarcoma
- Liposarcoma
- Osteosarcoma

Skin SCC

Thyroid cancer

Urological

- Bladder cancer
- Prostate cancer
- RCC

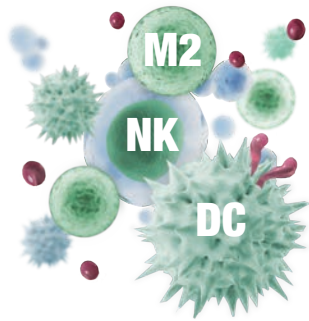


# AXL is a key survival mechanism 'hijacked' by aggressive cancers and drives drug resistance, immune-suppression & metastasis

very low expression under healthy physiological conditions

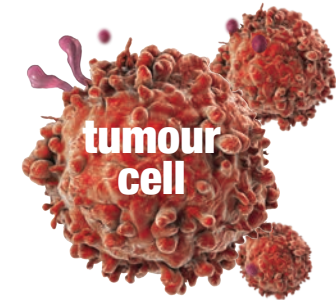
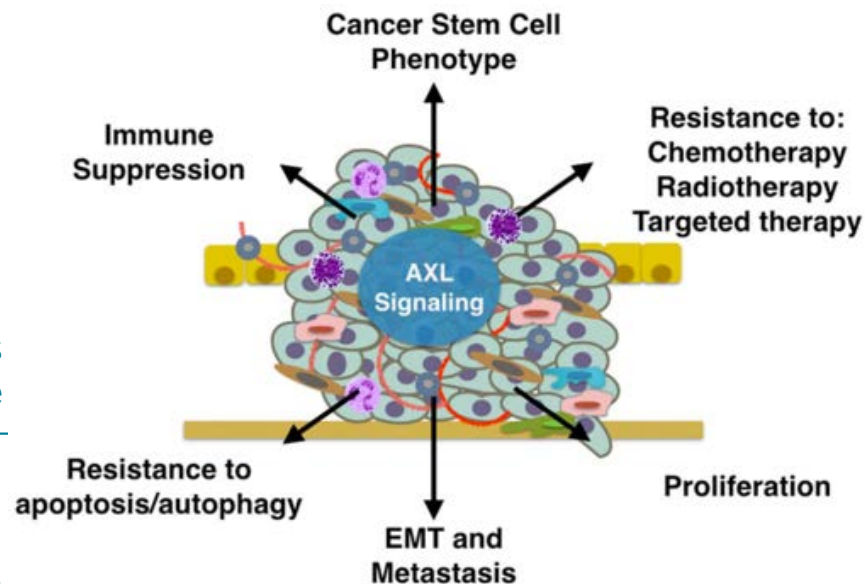
overexpressed in response to hypoxia, inflammation, cellular stress & drug treatment

overexpression correlates with worse prognosis in most cancers



AXL increases on immune cells and suppresses the innate immune response

- M1 to M2 macrophage polarisation<sup>1</sup>
- Decreased antigen presentation by DCs<sup>2</sup>
- Prevent CD8+ T cell mediated cell death<sup>3</sup>
- Activates Treg cells



AXL increases on the tumor cell and causes cancer escape and survival

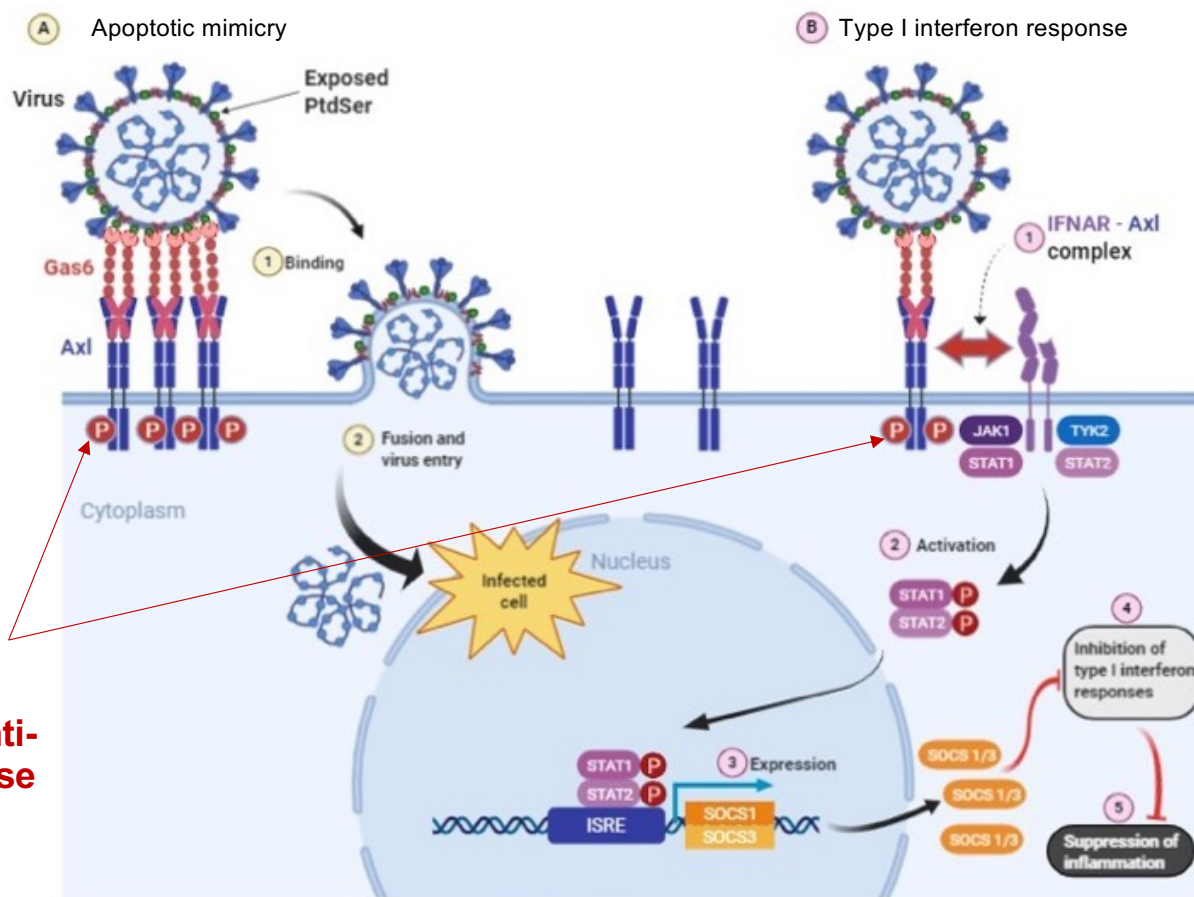
- AXL is a unique type I interferon (IFN) response checkpoint
- Acquired drug resistance
- Immune cell death resistant
- Metastasis

<sup>9</sup> DC- dendritic cells Treg – Regulatory T Cell

1.Ludvig et al Can Res, 2018; Davidsen et al., submitted 2.Kurowska-Stolarska et al Nature Comm 2017; Rothlin et al Cell 2007 3.Ludvig et al Can Res, 2018; Davidsen et al., submitted

# AXL is targeted by enveloped viruses to enter cells and dampen the viral immune response

Enveloped viruses display phosphatidylserine that is recognized by GAS6, the AXL receptor ligand, that mediates viral entry through “apoptotic mimicry”.



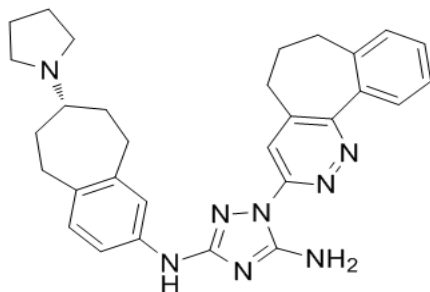
Viral-mediated AXL receptor activation dampens type I interferon responses, a key anti-viral defence mechanism for all cells

**bemcentinib blocks AXL-dependent viral entry and enhances anti-viral interferon response**

# Bemcentinib






## Bemcentinib, a first-in-class, potent, oral, highly selective AXL inhibitor



- ✓  $IC_{50} = 14 \text{ nM}$
- ✓ Uniquely selective for AXL
  - ✓ 50-100 fold selective *cf.* TAM kinases
- ✓ CMC scaled for regulatory filing
- ✓ Size 0 100mg HPMC capsules
- ✓ 3 years stability confirmed
- ✓ Once daily oral dosing
- ✓ Already trailed in >300 patients
- ✓ Favourable safety profile supports use in first line, high risk fragile patients
- ✓ Safety and tolerability profile supports use in combination with other drugs
- ✓ MOA is synergistic with other therapies enhancing response
- ✓ Global regulatory exposure with Fast Track Designation by FDA
- ✓ IMP available in stock for immediate clinical trial use

# BerGenBio pipeline - 3 selective AXL inhibitors in clinical development

## Multiple attractive opportunities in cancer and viral infection

Candidate	Targeted Indication	Discovery	Preclinical	Phase I	Phase II	Phase III.
Bemcentinib	>2L AML	Ph II safety and POC efficacy demonstrated in 39 patient trial				
Bemcentinib (combination with LDAC)	2L AML	Ph Ib Safety demonstrated, efficacy POC expansion study- 28 pts.				
 Bemcentinib (combination with Keytruda)	2L NSCLC. (chemo refractory)	Ph II safety and POC efficacy demonstrated in 50 patient trial, end points met				
	2L NSCLC (CPI refractory)	Ph II POC study on going 29 pts – stage 1 met end point				
	2L NSCLC (CPI+chemo refractory)	Ph II POC study ongoing 29 pts				
 Bemcentinib	COVID19	Ph II Efficacy & Safety study ongoing 120 pts				
Tilvestamab (BGB149)	TBA	Ph I Healthy volunteer study ongoing				
 BGB601	Various solid tumors	Ph I safety study ongoing				

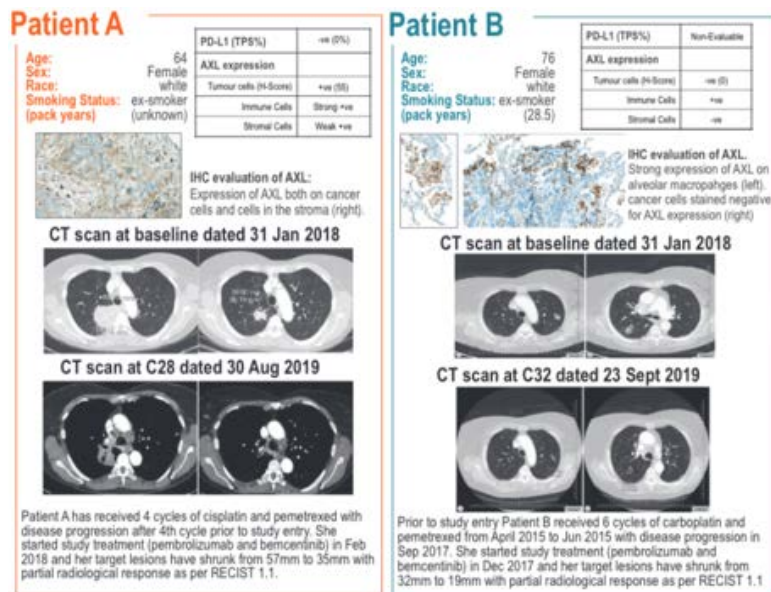
## Broad phase II clinical development plan with bemcentinib

		Clinical Proof-of-concept	Late stage Opportunities
Monotherapy Selected, biomarker directed patients	AML / MDS	Completed	
	Glioblastoma (IIT)	Ongoing	
	COVID19	Ongoing	
Chemotherapy Combinations Improve responses in hard to treat settings	AML + LDCT (LDAC)	Complete. -EXPANSION	
	Pancreatic, (IIT)	Ongoing	
	NSCLC (IIT)	Ongoing	
Immunotherapy Combinations Target resistance, enlarge addressable patient population	NSCLC (PD-L1 / AXL all comers)	Cohort A Complete Cohort B ongoing - EXPANSION Cohort C ongoing	
	Melanoma, (IIT)	Ongoing	
	Mesothelioma (IIT)	In set-up	
Targeted Therapy Combinations Target resistance, enlarge addressable patient population	NSCLC + EGFRi	Completed	
	Melanoma, (IIT)	Ongoing	



## Companion Diagnostic (CDx)

- Developed a proprietary duplex IHC method with composite AXL tumor-immune Score (cAXL)
- A proprietary diagnostic algorithm using IHC scoring of AXL on tumor cells and on immune cells to identify solid tumour (NSCLC) patients that will respond / benefit from bemcentinib + CPI



### Patient A: RESPONDER

- AXL stained +ve on tumor cells
- 61% tumor shrinkage

### Patient B: RESPONDER

- AXL stained -ve on tumor cells
- AXL stained +ve on alveola macrophages
- 59% tumor shrinkage

*AXL mediates aggressive cancer traits through EMT and Immune suppression in the tumour microenvironment:*

### Patient A: AXL +ve staining on lung tumour cells

- AXL mediated EMT in tumour cells
- AXL+ve Mesenchymal tumour cells are drug resistant & immune evasive

### Patient B: AXL +ve staining on lung macrophages

- AXL is required to stabilize M2 macrophages
- M2 microphases are immune suppressive
- Bemcentinib inhibits AXL and macrophages switch to M1
- M1 macrophages are immune promoting

## AXL inhibitors – emerging competitive landscape





# Bemcentinib clinical development in COVID19

## ACCORD-2 trial

To evaluate the efficacy and safety in hospitalized COVID19 patients

First compound selected by UK Govt. COVID19 Therapeutic Task Force

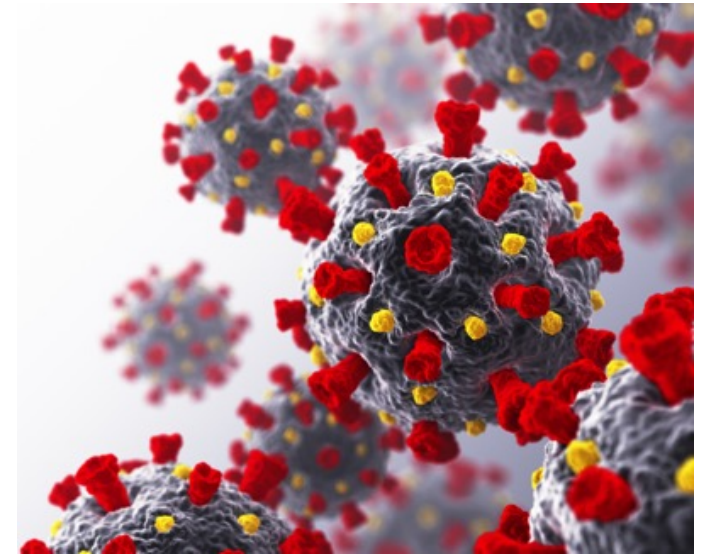
Trial funded by UK Govt.

A multicentre, randomised Phase II (120 patients) seamless Phase III transition option



## BerGenBio's bemcentinib selected to be fast-tracked as a potential treatment for COVID-19

- Preclinical data suggest that bemcentinib is potentially useful for the treatment of early SARS-CoV-2 infection, as it selectively inhibits AXL kinase activity
- Bemcentinib selected as the first candidate to be fast-tracked in a new UK national multi-centre randomised Phase II clinical trial initiative to investigate potential treatments for hospitalised COVID-19 patients
- ACCORD (**A**Ccelerating **C**COVID-19 **R**esearch & **D**evelopment platform) study is funded by the UK Department of Health and Social Care and UK Research and Innovation
- Study is a collaboration between the UK Government Scientific Office, the NIHR's Biomedical Research centres and clinical research company IQVIA
- Professor Tom Wilkinson is the academic lead of ACCORD-2, based at the National Institute for Health Research (NIHR) Southampton Biomedical Research Centre
- The study will test 120 patients across 6 UK NHS hospital trusts, with the first patients due to be treated imminently



# Protocol title: A Multicentre, Seamless, Phase 2 Adaptive Randomisation Study to Assess the Efficacy and Safety of Multiple Candidate Agents for the Treatment of COVID-19 in Hospitalised Patients

## Rationale:

There are currently no approved therapeutic agents available to treat coronaviruses such as severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), the causative agent of COVID-19 disease, and there is an urgent public health need for rapid development of such interventions. This adaptive platform study is designed to rapidly assess multiple candidate agents as treatments for COVID-19. Candidate drugs that are initially assessed as being efficacious will be moved from an evaluation (pilot) stage to a confirmatory stage, with candidate agents being added to and removed from the study on an ongoing basis, depending on the results of their evaluation. Patients to be included in the study will be hospitalised and may require either supplemental oxygen, noninvasive ventilation or high flow oxygen devices, or invasive mechanical ventilation or extracorporeal membrane oxygenation (ECMO).

## Objectives:

Stage 1: To evaluate the efficacy of candidate agents as add-on therapies to standard of care (SoC) in patients hospitalised with COVID-19 in a screening stage.

Stage 2: To confirm the efficacy of identified efficacious candidate agents in patients hospitalised with COVID-19 in an expansion stage.

## Endpoints:

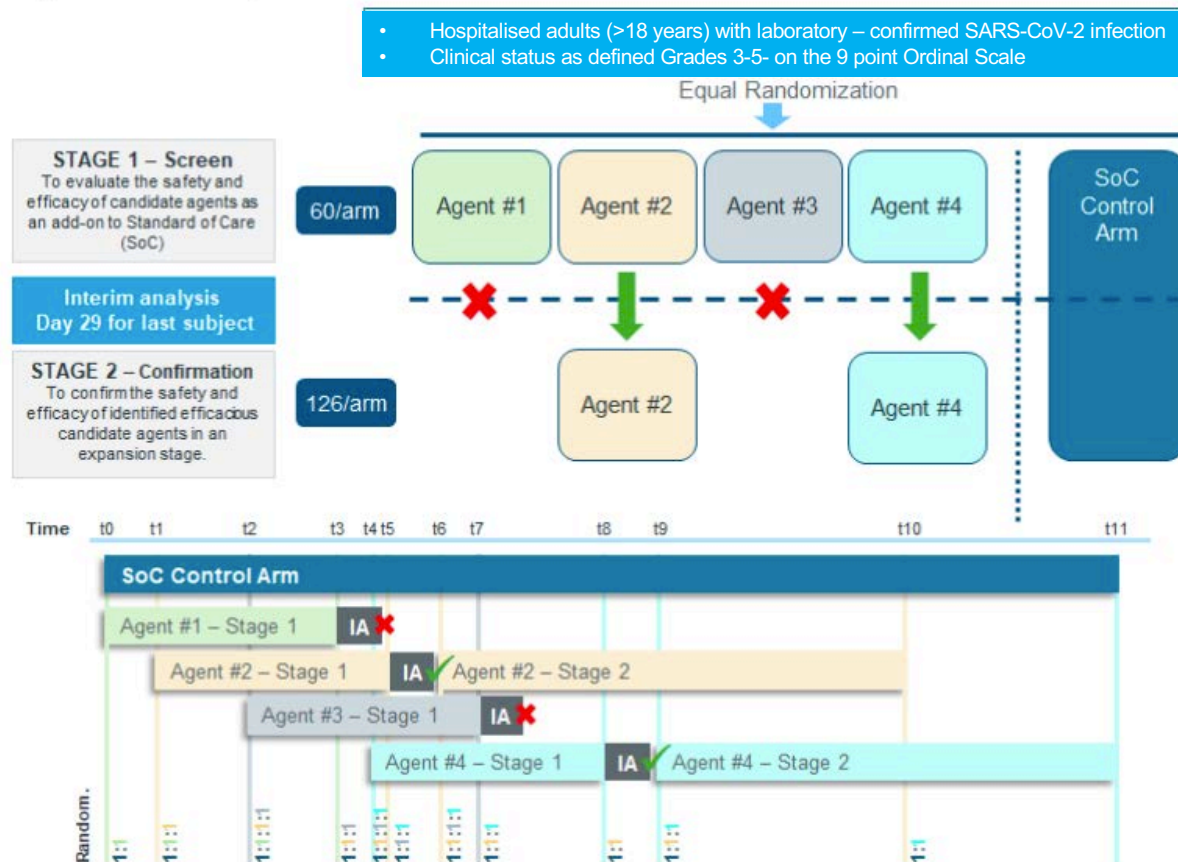
- Time to clinical improvement of at least 2 points (from randomisation) of patients stage 3, 4 or 5 on a 9-point category ordinal scale, or live discharge from the hospital, whichever comes first (this will also define the “responder” for the response rate analyses).

### 9-Point Category Ordinal Scale:

0. Uninfected, no clinical or virological evidence of infection
1. Ambulatory, no limitation of activities
2. Ambulatory, limitation of activities
3. Hospitalised – mild disease, no oxygen therapy
4. Hospitalised – mild disease, oxygen by mask or nasal prongs
5. Hospitalised – severe disease, noninvasive ventilation or high flow oxygen
6. Hospitalised – severe disease, intubation and mechanical ventilation
7. Hospitalised – severe disease, ventilation and additional organ support – pressors, renal replacement therapy (RRT), extracorporeal membrane oxygenation (ECMO)
8. Death

# ACCORD Study overview

**Figure 1 Study Schema**



IA=interim analysis; SARS-CoV-2=severe acute respiratory syndrome coronavirus 2; SoC=standard of care.

Note: This figure shows a hypothetical situation, where in Stage 1 of the study there are 4 candidate agents being compared with the SoC, of which 2 candidate agents progress to Stage 2.

Study dimensions:

- 6 NHS sites across UK
- Randomized Phase II
- 120 patients ( 60 receive bemcentinib, 60 in SoC control group)
- IQVIA are the CRO
- Standard bemcentinib dosing
- 15 day dosing schedule
- Independent Data monitoring Committee
- Seamless transition to stage 2 (phase III)

Ref. BGBC003 / NCT02488408

# Bemcentinib clinical development in Acute Myeloid Leukemia (AML) and Myelodysplastic syndromes (MDS)

Objective: to evaluate the safety and efficacy of bemcentinib in AML and MDS

Bemcentinib monotherapy in patients relapsed AML or MDS

Bemcentinib in combination with low-dose cytarabine (LDAC) in 1L newly diagnosed or relapsed patients with AML

Bemcentinib in combination with LDAC in 2L relapsed patients with AML





# Acute Myeloid Leukaemia (AML)

*Most common type of acute leukaemia in adults<sup>1</sup>*

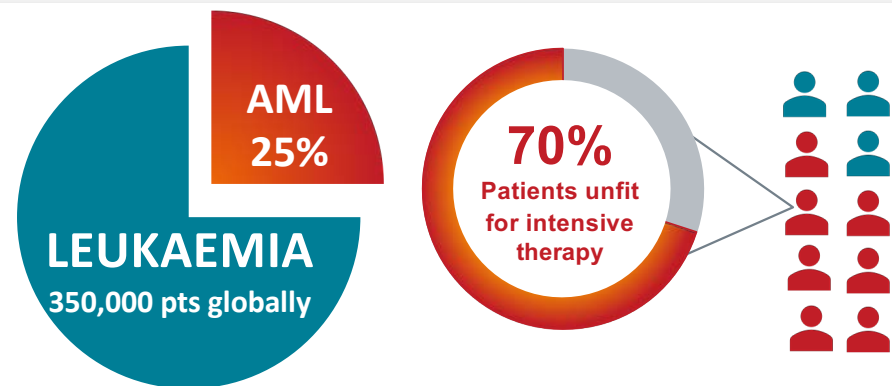
AML is a rare aggressive cancer of the blood and bone marrow characterised by difficult to treat malignancies

~ 21,000 new cases diagnosed and >11,000 deaths in the US in 2018<sup>2</sup>

AML makes up 32% of all adult leukaemia cases

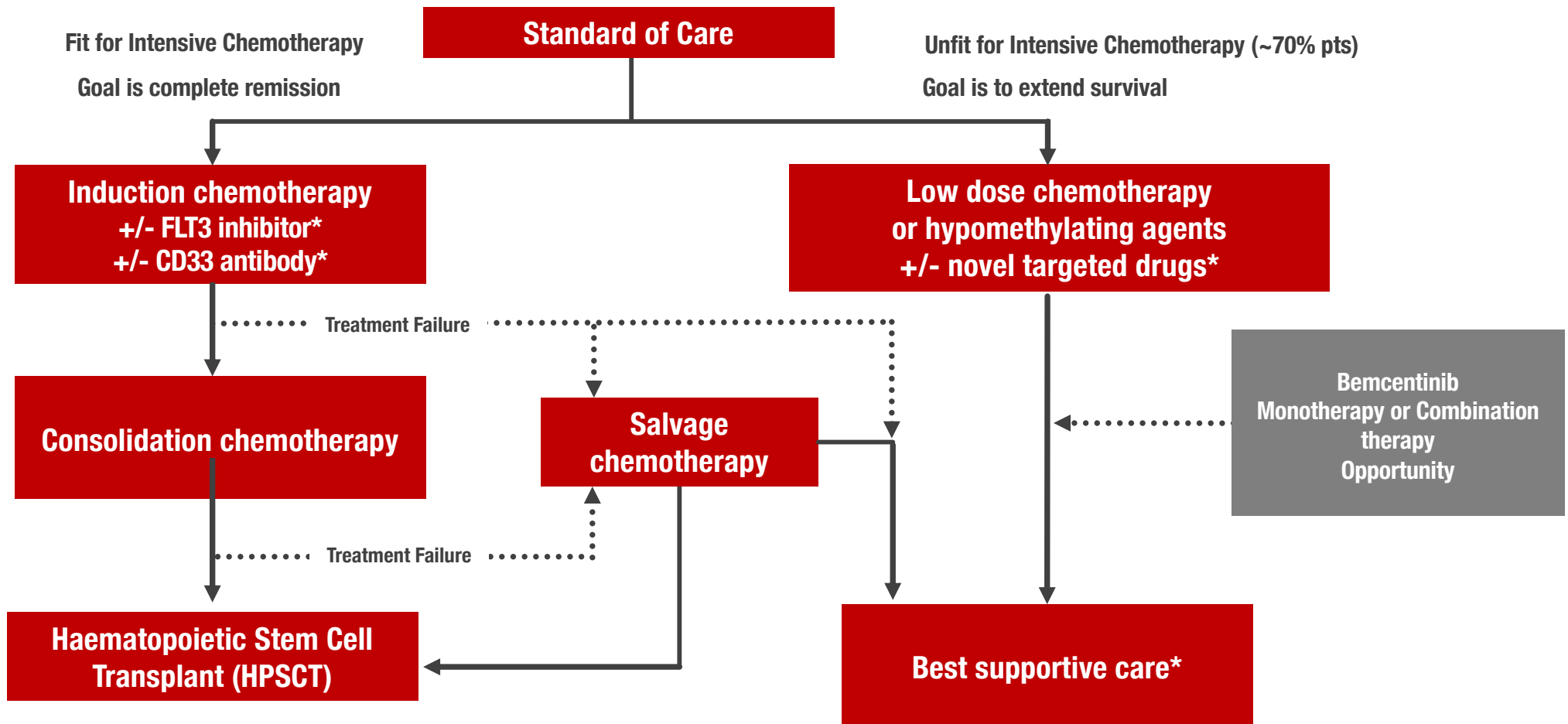
Occurs in a predominantly elderly, frail patient population; 68% of patients diagnosed with AML were aged >60 years<sup>6</sup>

5 year survival rates of 3-8% in patients over 60 years old<sup>7</sup>



(1) Cancer.gov; (2) SEER; (3) [https://www.who.int/selection\\_medicines/committees/expert/20/applications/AML\\_APL.pdf?ua=1ble](https://www.who.int/selection_medicines/committees/expert/20/applications/AML_APL.pdf?ua=1ble)  
(4) <https://www.cancer.net/cancer-types/leukemia-acute-myeloid-aml/statistics> (5) <https://www.businesswire.com/news/home/20190319005442/en/> (6) <http://asheducationbook.hematologylibrary.org/content/2010/1/62.long>, (7) <https://www.ncbi.nlm.nih.gov/books/NBK65996/>

# Acute Myeloid Leukaemia: Standard of Care & Bemcentinib Positioning



# Current Approach to AML in Elderly Patients Unfit for Intensive Chemotherapy

## Newly Diagnosed AML: Choice of Low Intensity Induction Therapy:

- Hypomethylating agent (HMA) +/- venetoclax (approved in US only)
- LDAC alone or in combination with venetoclax or glasdegib (approved in US only)
- Future direction: AML with mutation of FLT3, IDH1/2

Opportunity for  
Bemcentinib + LDAC

## 1<sup>st</sup> Relapse

- Clinical trial
- No approved therapy, but options may include HMA, LDAC or single agent venetoclax dependent on funding
- Best supportive care (BSC) or palliative care

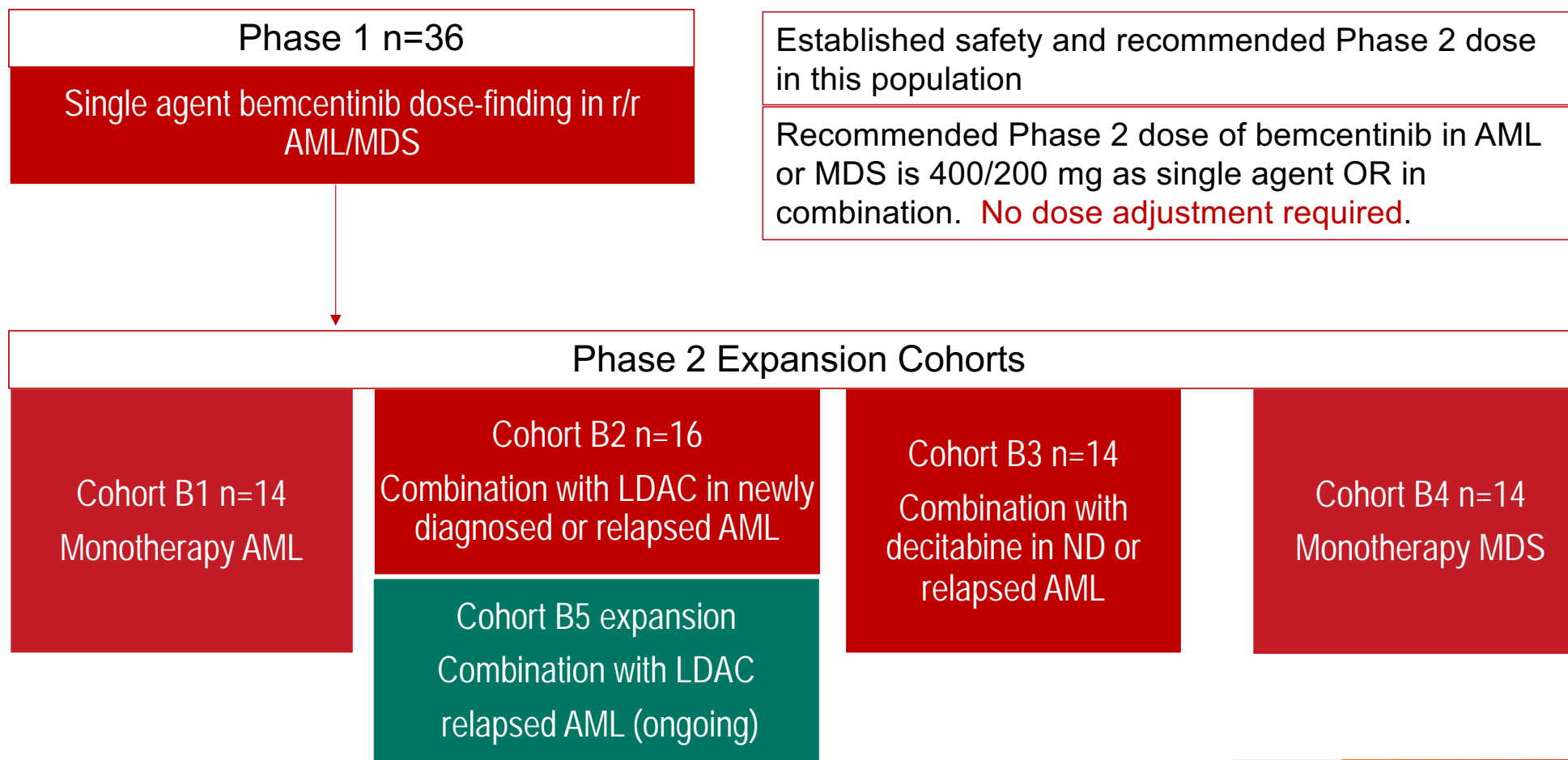
## 2<sup>nd</sup> Relapse

- Clinical trial
- BSC or palliative care

Opportunity for Single  
Agent Bemcentinib



## Bemcentinib clinical development in Acute Myeloid Leukemia, (BGBC003)



# Results Bemcentinib monotherapy in relapsed/refractory $\geq 2L$ r/r AML.



	Overall (n=27)		sAXL low (n=14)		sAXL high (n=11)	
	n	%	n	%	n	%
CR/CRi/CRp	6	22%	6	43%	0	0%
SD	8	30%	3	21%	5	45%
PD*	13	48%	5	36%	6	55%
<b>ORR</b>	<b>6</b>	<b>22%</b>	<b>6</b>	<b>43%</b>	<b>0</b>	<b>0%</b>

• 2 evaluable patients were not evaluable for sAXL status  
 • Monotherapy responses. One additional response was reported in combination with decitabine for a total of 7 responses in phase I/II.  
 • 1 CR, 4 CRi, 1 CRp

\* PD includes patients who progressed or came off study before having completed 3 cycles of treatment.

$\geq 2L$  Relapse patients >75yrs  
 No approved SoC  
 Bemcentinib Monotherapy

AXL +ve\* patients

14/27  
**54%**

CR/Cri/CRp  
 6/14  
**43%**

Stable Disease

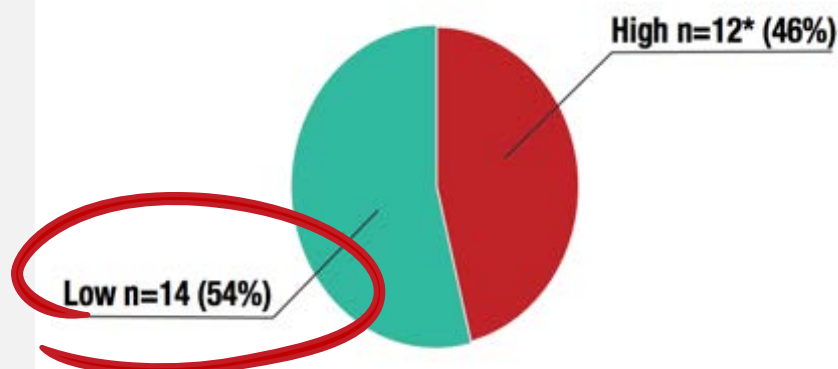
3/14  
**21%**

mDOR **3.1mo. (5.5\* mo.)**

Safety profile was well tolerated

\* including 2 patients with low dose decitabine, one remains in CR after 20 months

Biomarker: Soluble AXL (sAXL) at screen:  
Inversely correlated with AXL receptor activity



## Bemcentinib + LDAC combination is active and effective in 1L newly diagnoses unfit/elderly AML patients

- 4/6 patients with ORR
- mDoR immature >12months and all 4 responding patients ongoing
- Responding patients have poor risk factors

### Clinical Activity in Newly-Diagnosed Patients

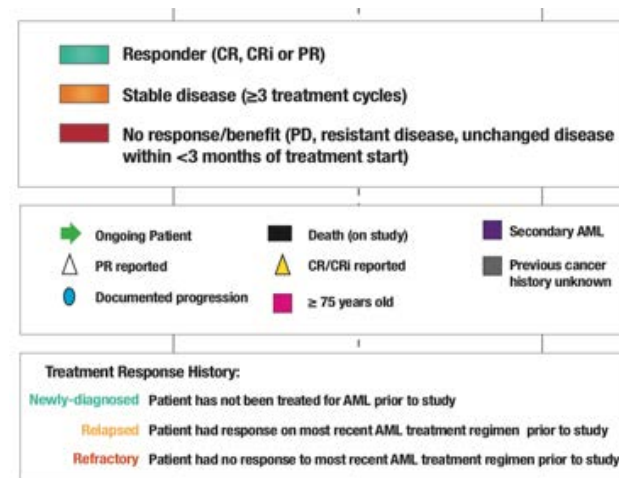
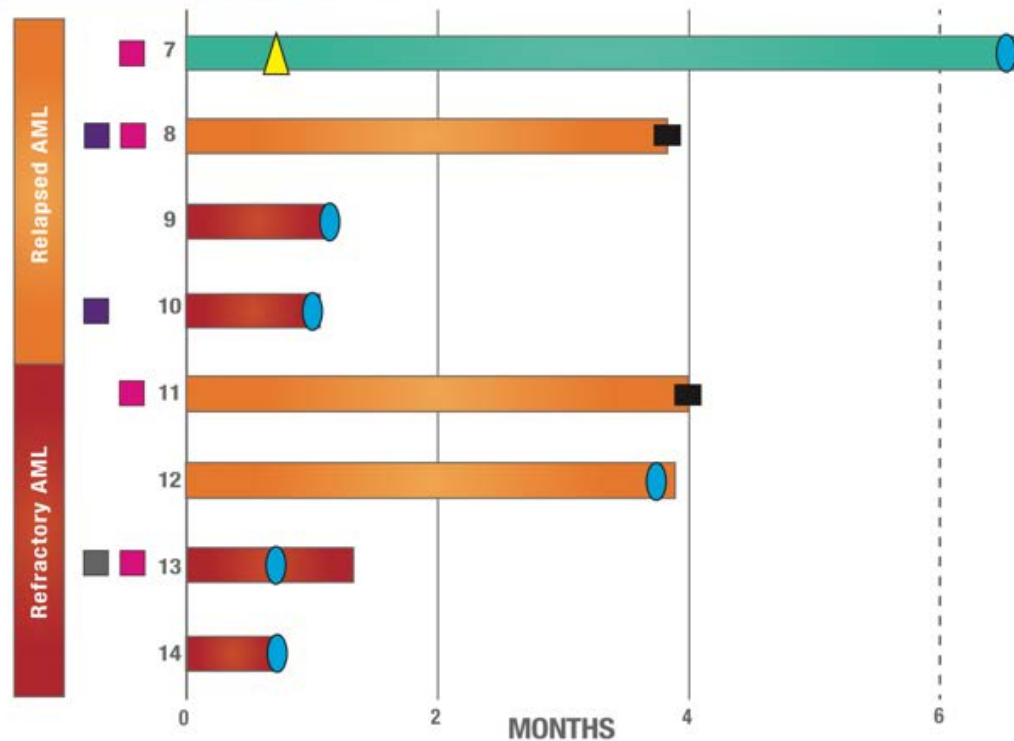
#### Time on treatment



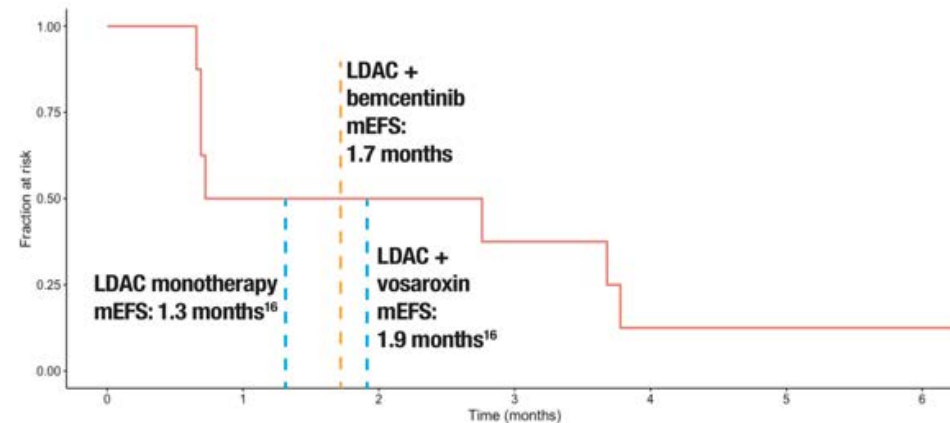
# Bemcentinib + LDAC in r/r AML patients

## Clinical Activity in Relapsed/Refractory Patients

### Time on treatment



## Event-free Survival (Relapsed/Refractory Patients)



2L r/r AML LDAC combo expansion cohort 28pts ongoing

# Registration strategies for bemcentinib in AML under consideration

Bemcentinib has FAST TRACK DESIGNATION by FDA in AML.

3 possible registration paths are apparent, in slightly different patient populations

Scientific advice will be sort early 2020, route to registration to be discussed

## 1. 2L Bemcentinib + LDAC combination

- relapse patients >60 years, patients having failed HMA or HMA+Venetoclax
- rPh II / III, to receive bem+LDAC or LDAC alone
- End points: ORR and DoR
- Anticipated sample size 200 with 6 month f/u

## 2. ≥2L bemcentinib mono therapy

- Heavily pre-treated, ≥2L relapse patients >75yrs, with low sAXL
- sAXL assay is a CLSI validate Clinical Trial Assay method performed at a CLIA lab.
- Possible single arm or comparator being best supportive care (BSC) or palliative care
- End points: ORR and DoR
- Anticipated sample size 100 with 6 month f/u

## 3. 1L Bemcentinib + LDAC combination

- 1L patients >60 yrs, unsuitable for HMA+Venetoclax
- rPh II / III
- End points: ORR and DoR/OS
- Anticipated sample size 200 with 12 month f/u

Ref. BGBC008 / NCT03184571

# Bemcentinib clinical development in Non Small Cell Lung Cancer (NSCLC)

Objective: to improve the effectiveness of immune check point inhibitor (CPI) (pembrolizumab/Keytruda) refractory NSCLC patients, with a well tolerated, effective, and convenient drug

Chemotherapy refractory patients

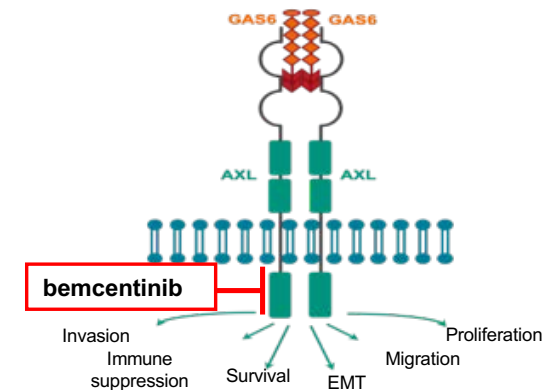
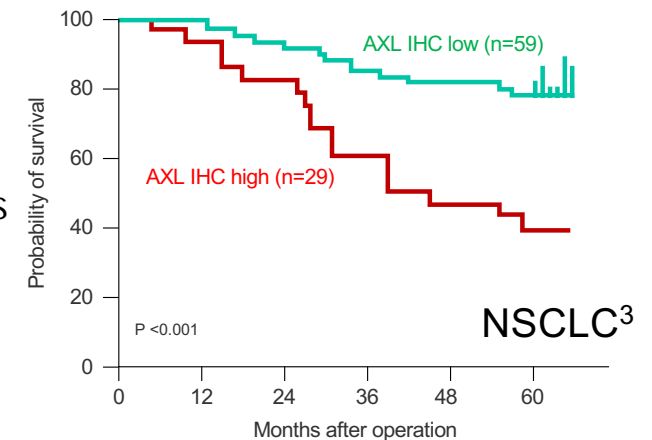
CPI +/- chemotherapy refractory patients

CPI+Chemotherapy refractory patients



# Rationale for AXL inhibitor bemcentinib as an immuno-oncology agent in combination with check point inhibitor (CPI)

- AXL drives tumor EMT and resistance to cytotoxic lymphocyte-mediated cell killing<sup>1</sup>
- AXL receptor tyrosine kinase is a negative prognostic factor for many cancers including NSCLC<sup>2</sup>
- AXL expression is associated with anti-PD-1 therapy failure in melanoma patients<sup>3</sup>
- AXL is expressed by suppressive tumor-associated M2 macrophages and dendritic cells<sup>4</sup>
- Bemcentinib is a first-in-class highly selective, potent, and orally bioavailable, small molecule AXL kinase inhibitor
- Bemcentinib reverses EMT, repolarizes TAMs and potentiates efficacy of immunotherapy in murine cancer models<sup>4</sup>





NSCLC causes more cancer related deaths than breast, colon, pancreas and prostate combined

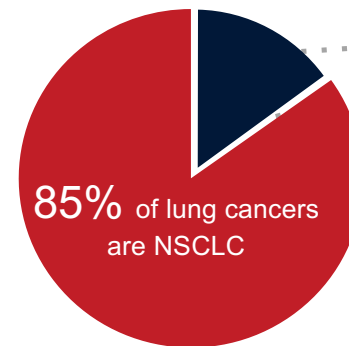
The largest cancer killer, most patients depend on drug therapy

### The most common type of cancer

2.09 million new cases of lung cancer diagnosed/yr worldwide, making up 11.6% of all cancer cases<sup>1</sup>

1.76 million lung cancer deaths/yr worldwide<sup>1</sup>

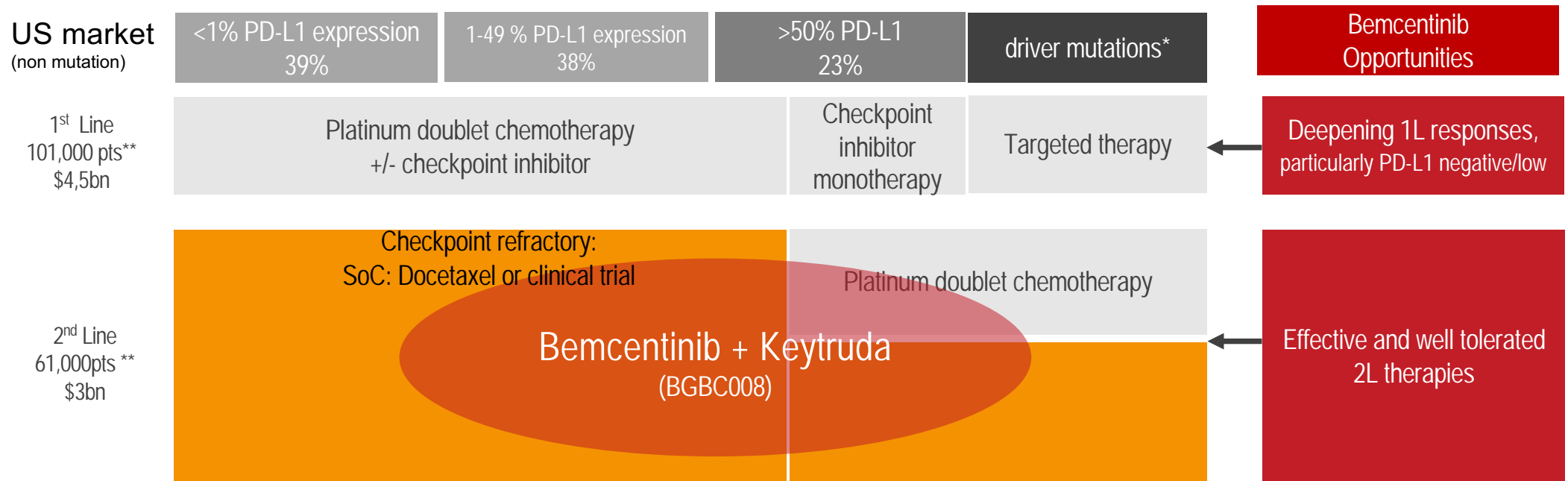
5-year survival rate is 3.5% in patients with PD-L1 <1%, and **12.6%** in patients PD-L1 1-49%





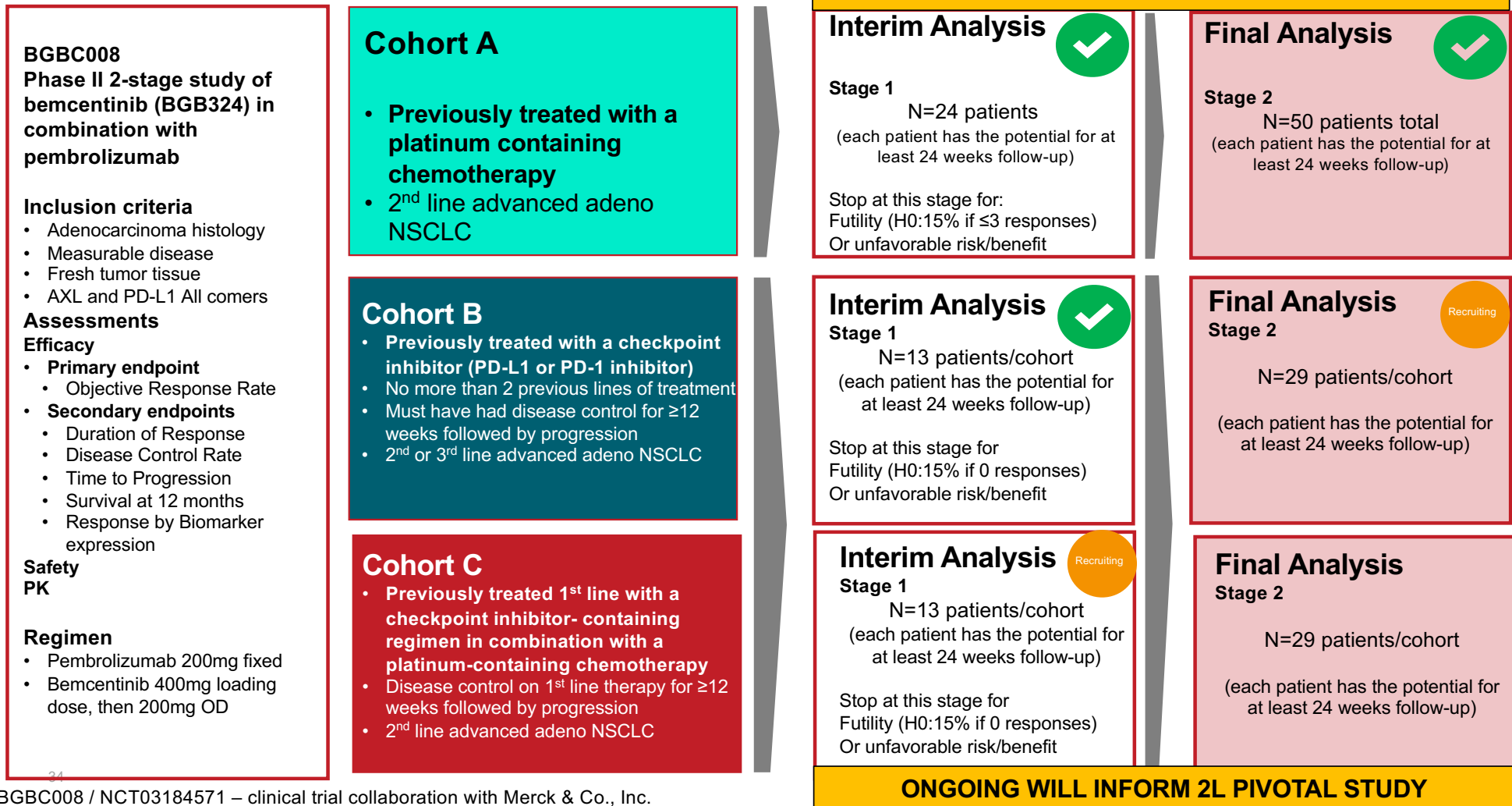
# Non- Small Cell Lung Cancer (NSCLC)

Rapidly evolving SoC creates opportunities for novel effective, chemo free well tolerated regimens



# Bemcentinib + KEYTRUDA in refractory/relapsed NSCLC

## Phase II Study Design



# Cohort A Patient Disposition and Demographics\*

Patient disposition		N
Screened		74
Enrolled		50
Evaluable		44
Ongoing		9

Patient demographics		N (%)
Age	Median	65
	Range	39-82
ECOG at screen	0	22 (44%)
	1	28 (56%)
Sex	Female	20 (40%)
Smoking Status	Smoker	10 (20%)
	Ex-smoker	29 (58%)
	Never smoked	10 (20%)
	Unknown	1 (2%)

Disease mutations		N (=50)
None		36 (72)
KRAS		7 (14)
TP53		2 (4)
EGFR		3 (6)
Other		4 (8)

## Safety Summary

The safety profile of combination treatment is consistent with that of each individual drug

Treatment related adverse events were generally mild and reversible

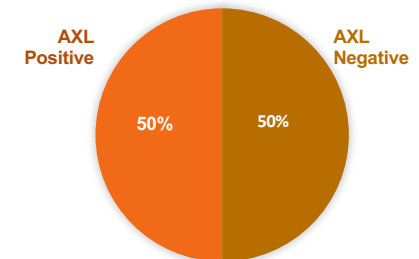
Treatment related adverse events were considered to be less severe and better tolerated than for other TKIs or CPI combinations used in NSCLC

## Most frequent TRAEs (≥10% dosed pts)

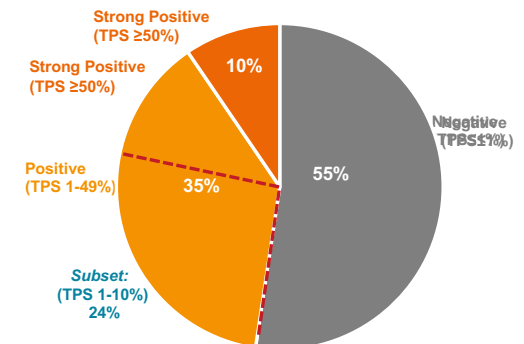
Event Terms	All Grades		Grade ≥3	
	n	%	n	%
Transaminase increased*	19	38 %	7	14%
Asthenia / Fatigue	15	30 %	4	8%
Diarrhoea	12	24 %	0	0%
Nausea	7	14 %	0	0%
Anaemia	6	12 %	1	2%
Blood creatinine increased	6	12 %	0	0%
Decreased appetite	6	12 %	0	0%
Pruritus	5	10 %	0	0%

## Biomarker

### cAXL status n = 30



### PD-L1 status n = 37

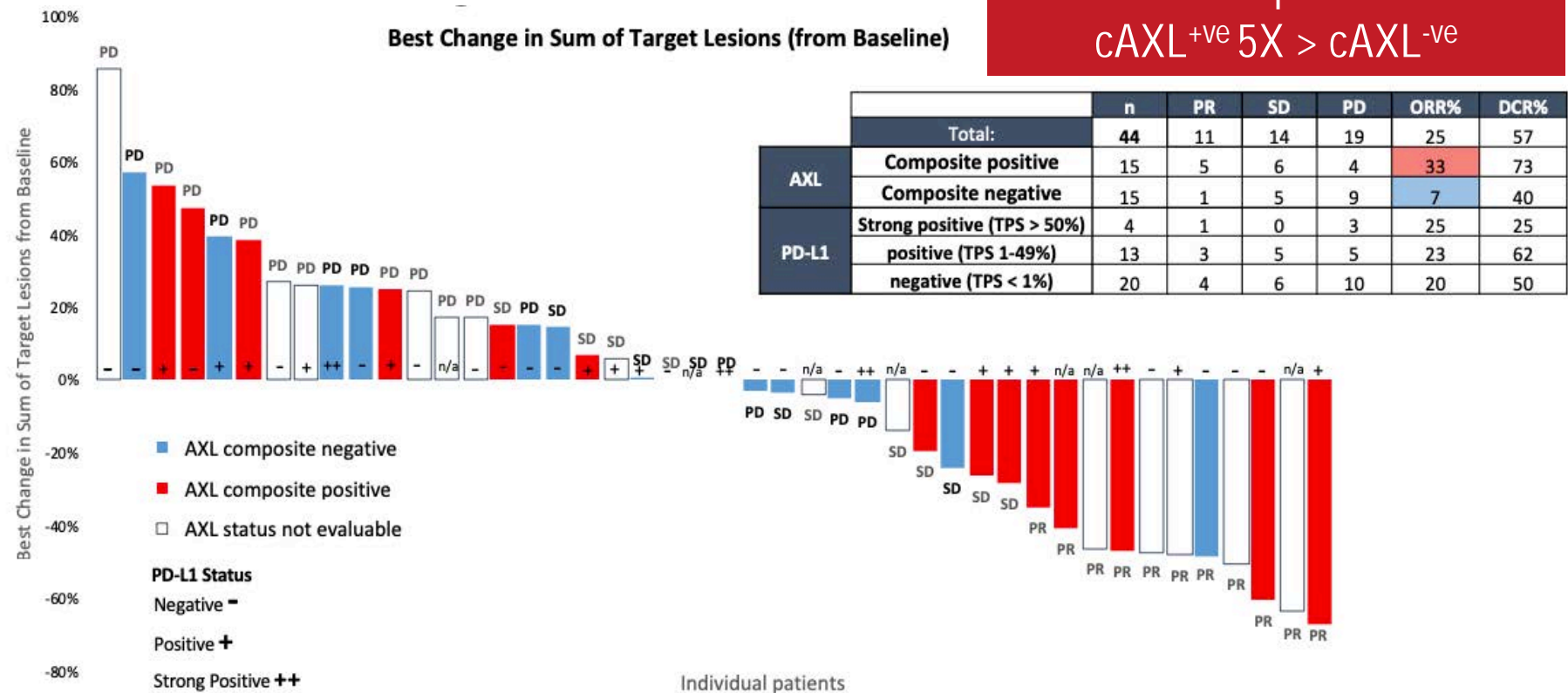


\*Data cutoff (30 Sep 2019)

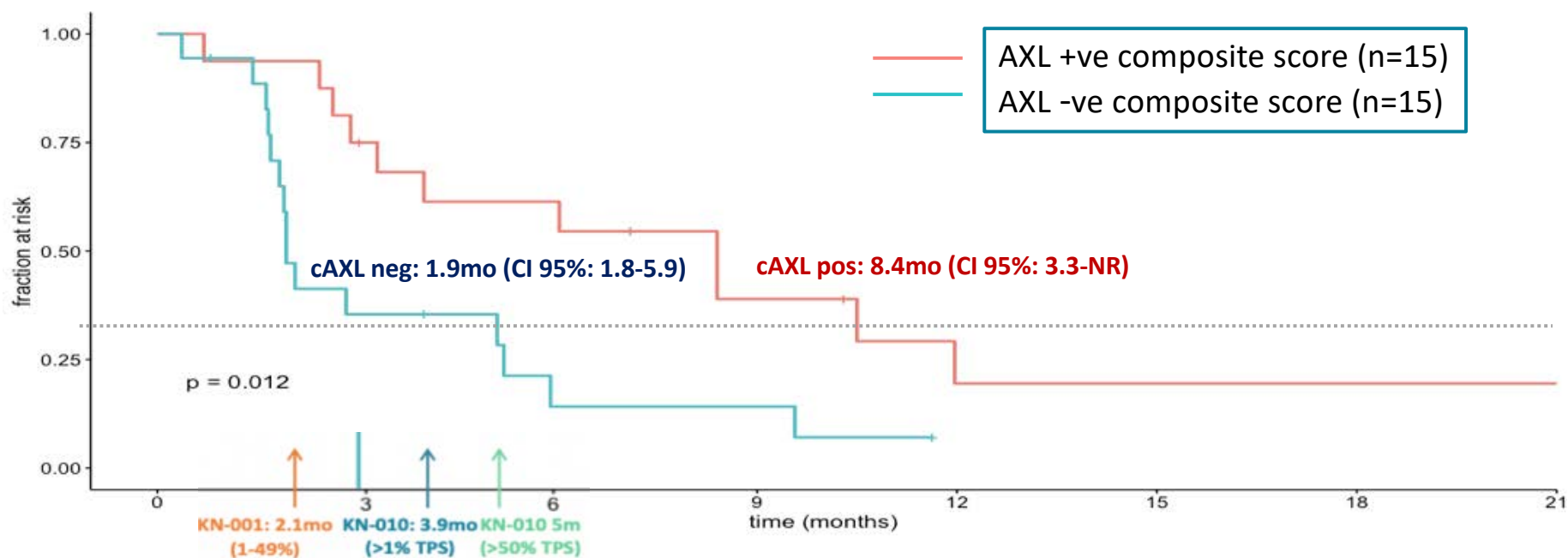
# Cohort A: Anti-tumor activity of bemcentinib in combination with pembrolizumab

## Change in tumour size from baseline by RECIST 1.1

Primary endpoint met:  
Overall Response Rate  
cAXL<sup>+ve</sup> 5X > cAXL<sup>-ve</sup>



## Cohort A: >4 X improvement in mPFS\* in composite AXL positive patients



- ✓ 4-fold improvement in cAXL +ve vs. cAXL -ve patients.
- ✓ 4-fold improvement in what might be expected in the same patient population with Keytruda monotherapy



## Cohort B: Bemcentinib + KEYTRUDA in CPI refractory patients

### CHECK POINT INHIBITOR REFRACTORY PATIENTS: precise and specific definition

Patients must have reported an initial clinical benefit (CR, PR or SD) for at least 12 weeks and subsequently progressed on treatment with an anti-PD1/L1 monoclonal antibody (mAb) administered either as monotherapy, or in combination with other checkpoint inhibitors or other therapies. PD-1 treatment progression is defined by meeting all of the following criteria:

- a) Has received at least 2 doses of an approved anti-PD-1/L1 mAb.
- b) Has demonstrated disease progression after PD-1/L1 as defined by RECIST v1.1. The initial evidence of disease progression (PD) is to be confirmed by a second assessment no less than four weeks from the date of the first documented PD, in the absence of rapid clinical progression.
- c) Progressive disease has been documented within 12 weeks from the last dose of anti-PD-1/L1 mAb. Seymour et al; iRECIST: Guidelines for response criteria for use in trials testing immunotherapeutics. Lancet Oncol 18: e143-52

This determination is made by the investigator. Once PD is confirmed, the initial date of PD documentation will be considered the date of disease progression.

- a) Other therapies not to be administered between last dose of anti PD-1/L1 mAb and commence of clinical trial agent



Jan 2020

### Interim Analysis Cohort B Stage 1 (N=13 patients) CONFIRM PROGRESSION TO STAGE 2

- Recruitment continues to enroll additional 16 patients
- Protocol amended to limit to 2L patients

## Development strategy for Bemcentinib in NSCLC (ad. & Sc. )

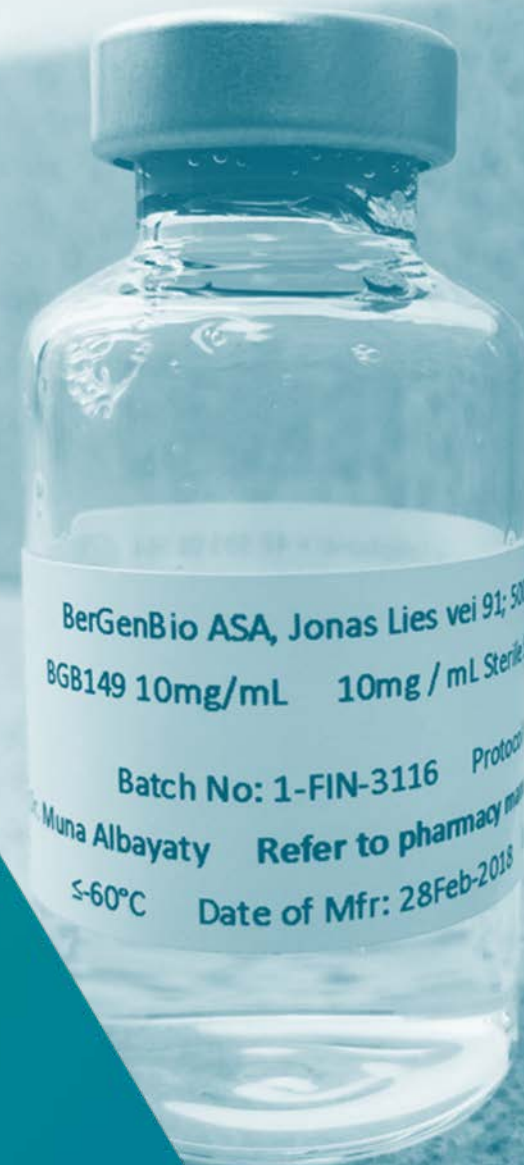
Clinical Position	Patient Population	Concept	Development Plan – target conditional approval / BT
2L IO(+chemo) refractory	Stage III/IV Ad. PD-L1 all comer cAXL +ve.	Randomised Phase IIb / III Bemcentinib + CPI vs. docetaxol 1° endpoints: Interim mPFS, (for C/A A) 6 & 12mn OS, OS (for full approval) 2° endpoints: ORR, DoR, Safety, tolerability.	<ol style="list-style-type: none"> <li>1. Pending BGBC008 cohort B + C</li> <li>2. SA advice from FDA &amp; EMA</li> <li>3. cAXL assay validation in BGBC008 B&amp;C</li> </ol>
1L	TBA		





# BGB149

## anti-AXL monoclonal antibody



## BGB149: Anti-AXL monoclonal antibody

### Phase I clinical trial ongoing



Functional blocking fully-humanised IgG1 monoclonal antibody

Binds human AXL, blocks AXL signalling

High affinity (KD: 500pM), Anti-tumour efficacy demonstrated *in vivo*

Robust manufacturing process established, 18 months stability

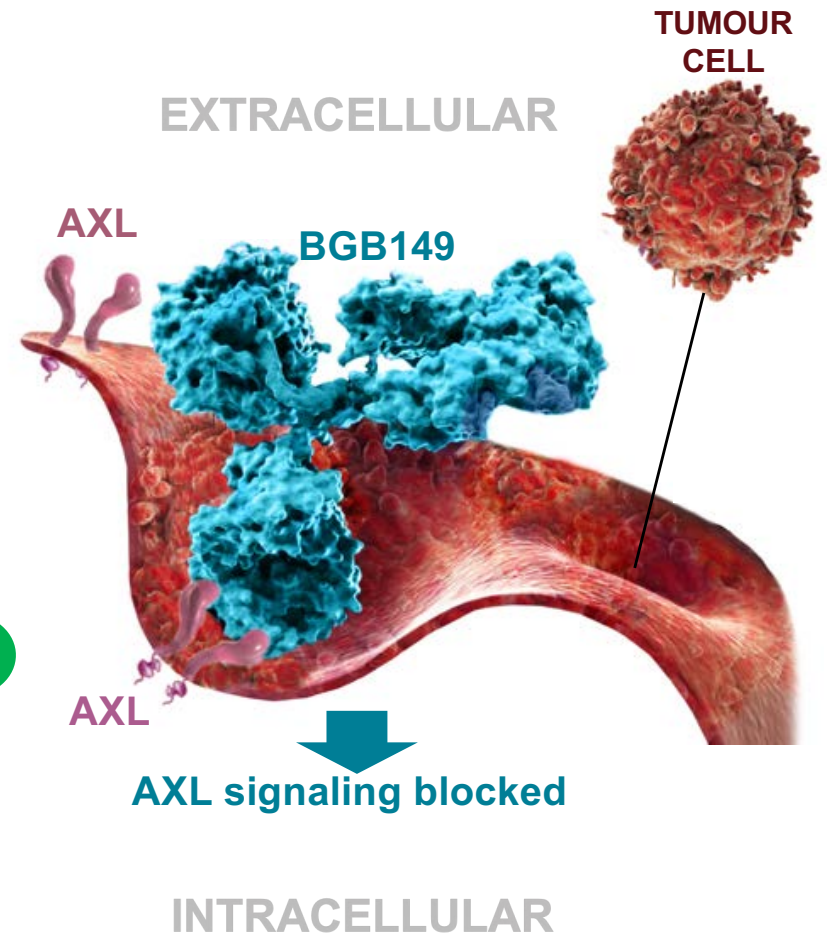
Phase Ia healthy volunteer SAD study complete

**Safety** – no dose limiting toxicity seen up to 3mg/kg dose

**Pharmacokinetics** - exposure predictable with dose proportional C<sub>max</sub> increase

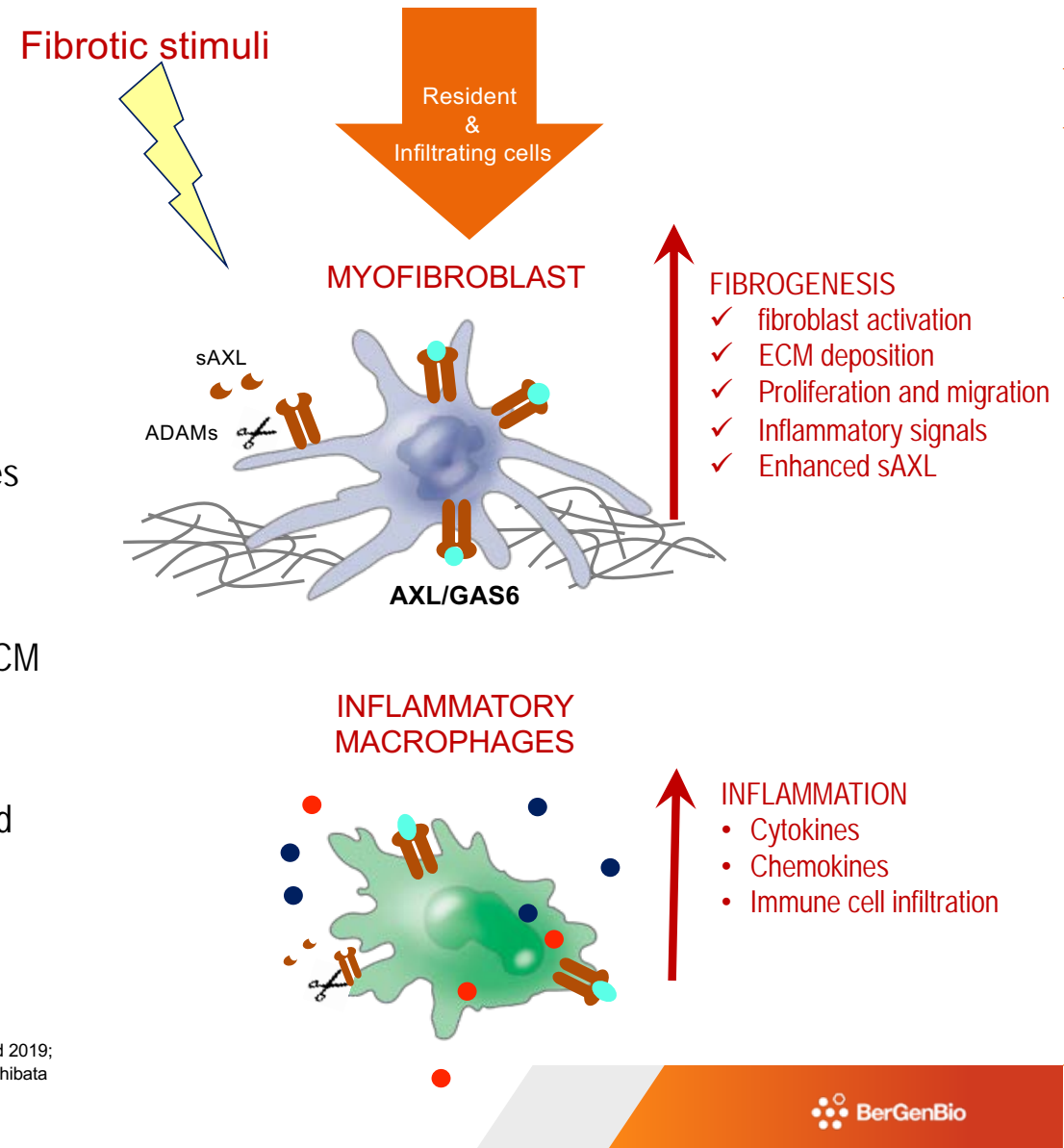
Confirmatory evidence of *in vivo* target engagement with sAXL -- stabilisation in circulation

Phase I safety trial ongoing



# The role of AXL in fibrosis

- AXL Regulates and modulates key fibrogenic pathways
  - TGFb signaling<sup>1,2</sup>
  - Mechanosensing Hippo pathway<sup>3</sup>
  - Peroxisome proliferator-activated receptor<sup>4</sup>
- Axl regulates cellular plasticity implicated in fibrotic pathologies e.g. EMT, EndMT, Macrophage polarity
- AXL is a negative regulator of epithelial cell barrier integrity<sup>5</sup>
- Axl is required for hepatic stellate cell (HSC) activation and ECM deposition<sup>6</sup>
- Pharmacological modulation of Axl inhibits pre-clinical development of Liver (CCl<sub>4</sub> /HighFatDiet<sub>7</sub>), Renal (UUO<sub>8</sub>) and Pulmonary (Asthma<sup>9</sup>, Bleo<sup>10</sup>, IPF<sup>10</sup>) fibrosis

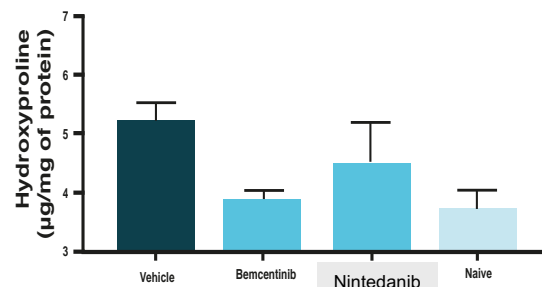


1 Gilbane ART 2015; 2 Reichl Hep. 2015; 3 Gibault ChemMed 2017; 4 Zhu AJTR 2016; Fujino Lab invest 2017, J Exp Med 2019; 6 Barcena J. Hep 2015; 7 Tutusaus A. Cell Mol Gastroenterol 2019 Hepatol. 2019; 8 Landolt L. Physiol Reports 2019; 9 Shibata J Immunology 2014; 10 BerGenBio ASA, unpublished; 11 Espindola MS. Am J Respir Crit Care Med 2018)

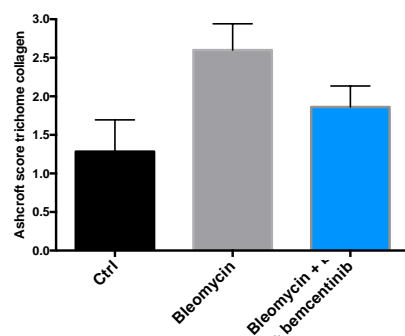
# AXL inhibition prevents fibrosis in a panel of pre-clinical models

## Lung

**Bemcentinib reduces fibrosis in a human xenograft model of IPF<sup>1</sup>**

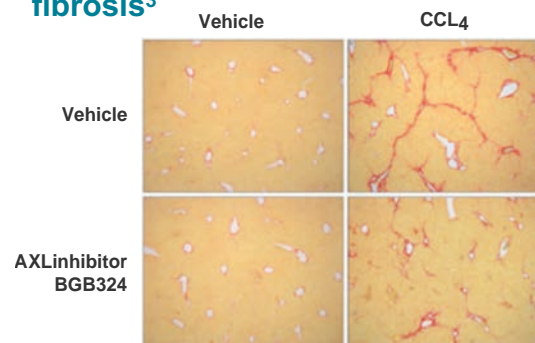


**Bemcentinib reduces bleomycin induced fibrosis<sup>2</sup>**

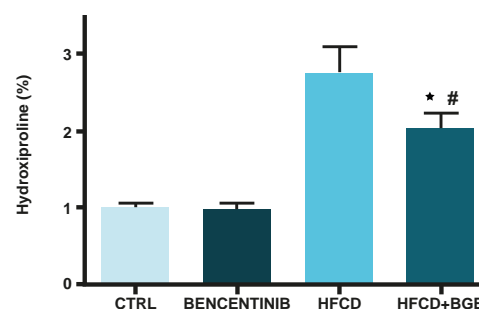


## Liver

**Bemcentinib reduces fibrosis in the CCL<sub>4</sub>-induced model of liver fibrosis<sup>3</sup>**



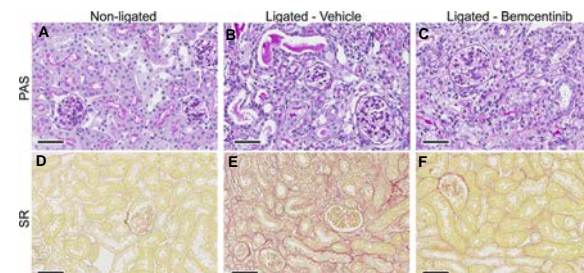
**Bemcentinib reduces fibrosis in a diet induced model of NASH<sup>4</sup>**



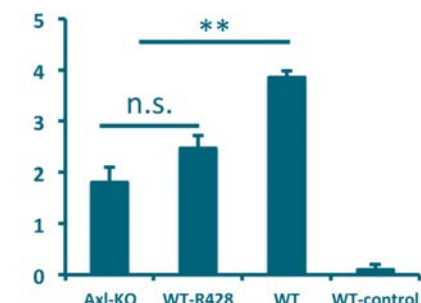
HFCD = high-fat, choline deficient diet  
Leads to NASH in animal models

## Kidney

**Bemcentinib reduces kidney fibrosis following Unilateral Ureteral Obstruction (UUO)<sup>5</sup>**



**Bemcentinib ameliorates anti-GBM induced lupus like nephritis and improved kidney function<sup>6</sup>**






**Corporate**





## BerGenBio pipeline – near term news flow

Candidate	Targeted Indication	Discovery	Preclinical	Phase I	Phase II	Next expected news
Bemcentinib	>2L AML	Ph II safety and POC efficacy demonstrated in 39 patient trial				
Bemcentinib (combination with LDAC)	2L AML	Ph Ib Safety demonstrated, efficacy POC expansion study- 28 pts.				ASH 2020 Update clinical & translational data
 Bemcentinib (combination with Keytruda)	2L NSCLC. (chemo refractory)	Ph II POC efficacy demonstrated in 50 patient trial, end points met				SITC 2020 Updated mOS
	2L NSCLC (CPI refractory)	Ph II POC study ongoing 29 pts – stage 1 met end point				SITC 2020 Stage 1 interim clinical and translational data
	2L NSCLC (CPI+chemo refractory)	Ph II POC study ongoing 29 pts				SITC 2020 Stage 1 interim clinical and translational data / WCLCL 2021
 Bemcentinib	COVID19	Ph II Efficacy & Safety study ongoing 120 pts				Q2/3 2020 Top line clinical data
Tilvestamab (BGB149)	TBA	Ph I Healthy volunteer study ongoing				Q4 2020 Top line clinical data
 BGB601	Various solid tumors	Ph I safety study Terminated (change in clinical plan and drug supply)				Update by collaborators

## Select Company Financials

Oslo Børs	BGBIO
Cash (YE'19 + Q1'20 - PIPE)	\$45m
Shares Outstanding	73,3m



# Board of Directors



## **Sveinung Hole, Chairman of the board**

- Non-Executive director of BerGenBio since 2010, chairman from 2019.
- Master of International Management.
- Representative of lead shareholder.



## **Prof. Stener Kvinnsland, MD.PhD Non-Executive Director**

- Non-Executive director of BerGenBio since 2015
- More than 30 years of experience in oncology, Chair Oslo University Hospital, CEO of the Bergen Hospital Trust, Head of the Department of Oncology and Professor of Medicine (Oncology) at the University of Bergen and Director Clinical R&D, Oncology for Pharmacia & Upjohn in Milan.



## **Dr. Debra Barker MD, Non-Executive Director**

- Non-Executive director of BerGenBio since 2019.
- Diploma in Pharmaceutical Medicine and MSc in immunology.
- Executive experience with Novartis, Roche, Smithkline Beecham and Knoll and served until recently as the Chief Medical and Development Officer at Polyphor Ltd.



## **Grunde Eriksen, Non-Executive Director**

- Non-Executive director of BerGenBio since 2019.
- Experienced capital markets advisor and investor.
- 18 years international experience in corporate finance and equity sales with SEB & Arctic Securities



## **Dr. Pamela Trail, Non-Executive Director**

- Non executive director of BerGenBio since 2019.
- PhD from the University of Connecticut.
- Strategic oncology leadership roles at Regeneron, MedImmune, Bayer Healthcare and BMS and served as CSO at Seattle Genetics

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Link to reports from Trinity Delta:

<https://www.bergenbio.com/investors/analyst-coverage/>

# Background published data on AXL role in viral infection



## **AXL mediates viral entry through “apoptotic mimicry” and suppresses the anti-viral type I interferon (IFN) response**

AXL promotes the infection of a wide range of enveloped viruses including pox-, retro-, flavi-, arena-, filo-, and alpha-viruses (Shimajima 2006, Brindley 2008, Meertens 2012, Dowall 2016, Meertens 2017).

Viral particle binding via GAS6-AXL potentially activates signal transduction through its tyrosine kinase domain to suppress type I interferon (IFN) signaling and facilitate viral replication (Bhattacharyya 2013, Meertens 2017).

AXL increases viral infection through two mechanisms:

- 1) enhanced viral entry through “apoptotic mimicry”; and
- 2) suppression of anti-viral type I interferon (IFN) responses

## AXL mediates viral entry through “apoptotic mimicry” and suppresses the anti-viral type I interferon (IFN) response

AXL signaling suppresses viral-induced IFN responses via SOCS1/3, leading to increased viral replication in infected cells and decreased anti-viral defenses of neighboring cells (Huang 2015, Chen 2018, Strange 2019).

Therapeutic AXL receptor inhibition ameliorated pulmonary pathology resulting from primary viral infection in experimental models, indicating an important role for AXL within the lung (Shibata 2014).

During primary respiratory syncytial virus (RSV) infection, AXL inhibition increased the number of IFN $\gamma$ -producing T cells and NK cells, suppressed RSV replication and whole lung levels of IL-4 and IL-13.

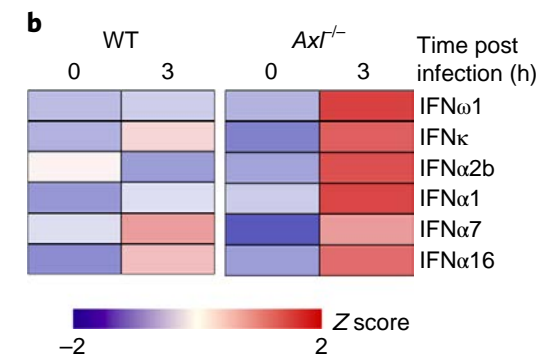
The lethal effect of intrapulmonary H1N1 infection inflammation was reduced by AXL inhibition. AXL inhibition in infected mice increased the number of IFN- $\beta$ -producing macrophages and dendritic cells and suppressed neutrophil infiltration.

*Axl*-null mice are resistant to ZIKA pathogenesis likely due to a combination of reduced virus entry and enhanced IFN responses (Hastings 2019), **indicating a potential role for AXL inhibitors as therapeutics during viral infection.**

# AXL is a unique type I interferon (IFN) response checkpoint

- IFNR signaling induces *AXL* expression<sup>4,5</sup>
- *AXL* is a critical negative feedback regulatory mechanism for TLR-induced type I interferon (IFN) responses in myeloid (dendritic cells, macrophage), NK and tumor cells<sup>1-4</sup>.
- *AXL* is an IFN checkpoint: *AXL* signaling blocks IFNR signaling via SOCS1/3 and TBK1<sup>5,6</sup>.
- *AXL* on dendritic cells is targeted by viruses (e.g. Zika) to abrogate IFN responses and inhibit anti-viral immunity<sup>7</sup>.

## *AXL inhibition enhances type I interferon gene response to viral infection*



1. Rothlin et al Cell. (2007) 131:1124–36
2. Lee et al., Front Immunol. (2019) 10:1261
3. Cañadas et al., Nat Med. 2018 Aug;24(8):1143-1150
4. Davidsen et al, submitted; Bougnaud, et al, unpublished.
5. Sharif et al., J Exp Med. (2006) 203(8):1891-901.
6. Cruz et al JCI Insight. 2019 Apr 2
7. Chen Nat Microbiol. 2018 Mar;3(3):302-309

# Bemcentinib showed effect against lethal EBOV infection in animal models conducted by PHE



Article

## Antiviral Screening of Multiple Compounds against Ebola Virus

Stuart D. Dowall <sup>1,6,\*</sup>, Kevin Bewley <sup>1</sup>, Robert J. Watson <sup>1</sup>, Seshadri S. Vasani <sup>1,2</sup>, Chandradhish Ghosh <sup>3</sup>, Mohini M. Konai <sup>3</sup>, Gro Gausdal <sup>4</sup>, James B. Lorens <sup>4</sup>, Jason Long <sup>5</sup>, Wendy Barclay <sup>5</sup>, Isabel Garcia-Dorival <sup>6</sup>, Julian Hiscox <sup>6,7</sup>, Andrew Bosworth <sup>1,7</sup>, Irene Taylor <sup>1</sup>, Linda Easterbrook <sup>1</sup>, James Pitman <sup>1</sup>, Sian Summers <sup>1</sup>, Jenny Chan-Pensley <sup>1</sup>, Simon Funnell <sup>1</sup>, Julia Vipond <sup>1</sup>, Sue Charlton <sup>1</sup>, Jayanta Halder <sup>3</sup>, Roger Hewson <sup>1,7</sup> and Miles W. Carroll <sup>1,7</sup>

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**Abstract:** In light of the recent outbreak of Ebola virus (EBOV) disease in West Africa, there have been renewed efforts to search for effective antiviral countermeasures. A range of compounds currently available with broad antimicrobial activity have been tested for activity against EBOV. Using live EBOV, eighteen candidate compounds were screened for antiviral activity in vitro. The compounds were selected on a rational basis because their mechanisms of action suggested that they had the potential to disrupt EBOV entry, replication or exit from cells or because they had displayed some antiviral activity against EBOV in previous tests. Nine compounds caused no reduction in viral replication despite cells remaining healthy, so they were excluded from further analysis (zidovudine; didanosine; stavudine; abacavir sulphate; entecavir; JB1a; Aimspro; celgosivir; and castanospermine). A second screen of the remaining compounds and the feasibility of appropriateness for in vivo testing removed six further compounds (ouabain; omeprazole; esomeprazole; Gleevec; D-LANA-14; and Tasigna). The three most promising compounds (17-DMAG; BGB324; and NCK-8) were further screened for in vivo activity in the guinea pig model of EBOV disease. Two of the compounds, BGB324 and NCK-8, showed some effect against lethal infection in vivo at the concentrations tested, which warrants further investigation. Further, these data add to the body of knowledge on the antiviral activities of multiple compounds against EBOV and indicate that the scientific community should invest more effort into the development of novel and specific antiviral compounds to treat Ebola virus disease.



# References

# References

## Non-Oncology

### Viruses

**Best SM. Viruses Play Dead to TAME Interferon Responses. *Cell Host Microbe* 2013 14:117**

-Thoughtful editorial on the role of AXL in viral infection accompanying *Bhattacharyya* 2013

**Bhattacharyya S *et al.* Enveloped viruses disable innate immune responses in dendritic cells by direct activation of TAM receptors. *Cell Host Microbe* 2013 14:136**

- Demonstration that GAS6-AXL complexes tether enveloped viruses to cells, activating AXL and dampening type I interferon responses.

**Chen J *et al.* AXL promotes Zika virus infection in astrocytes by antagonizing type I interferon signalling. *Nat Microbiol* 2018 3:302**

- Key article showing that Zika virus targets AXL on dendritic cells to block type I interferon responses including several type I interferon genes and IFN-stimulating genes.

**Dowall SD *et al.* Antiviral Screening of Multiple Compounds against Ebola Virus. *Viruses* 2016, 8:27**

- Report from Public Health England on the efficacy of bemcentinib inhibition of Ebola virus infection in vitro and in vivo.

**Hastings *et al.* Loss of the TAM Receptor Axl Ameliorates Severe Zika Virus Pathogenesis and Reduces Apoptosis in Microglia *iScience* 2019 13:339**

- Report showing that Axl knockout mice are resistant to ZIKV pathogenesis.

**Huang MT *et al.* Feedback regulation of IFN- $\alpha\beta$  signaling by Axl receptor tyrosine kinase modulates HBV immunity. *Eur. J. Immunol.* 2015. 45:1696**

-Axl silencing decreased HBV clearance of adult mice whereas enhanced HBV clearance. IFN- $\beta$  signaling induced Axl regulatory pathway and facilitated Treg-cell differentiation.

**Hunt CL *et al.* The Tyro3 Receptor Kinase Axl Enhances Macropinocytosis of Zaire Ebolavirus. *J Virology*, 2011, Jan:334**

- Demonstration that AXL mediates Ebola virus infection via micropinocytosis

**Meertens L *et al.* The TIM and TAM Families of Phosphatidylserine Receptors Mediate Dengue Virus Entry. *Cell Host & Microbe* 2012, 12:544**

- Report detailing the role of GAS6-AXL in Dengue viruses (DVs) infection.

**Meertens L *et al.* Axl mediates ZIKA virus entry in human glial cells and modulates innate immune responses. *Cell Rep* 2017 18:324**

Demonstration that bemcentinib blocks ZIKA virus infection of glial cells but blocking AXL-mediated viral entry and dampened innate immunity.

**Moller-Tank, S, Maury W. Phosphatidylserine receptors: Enhancers of enveloped virus entry and infection *Virology* 2014 :468-70:565**

Review of receptors driving apoptotic mimicry.

**Shibata T *et al.* Axl Receptor Blockade Ameliorates Pulmonary Pathology Resulting from Primary Viral Infection and Viral Exacerbation of Asthma. *J Immunology*, 2014, 192: 3569.**

- Therapeutic AXL receptor inhibition ameliorated pulmonary pathology resulting from primary viral infection in experimental models, indicating an important role for AXL within the lung.

**Shimajima M *et al.* Tyro3 family-mediated cell entry of Ebola and Marburg viruses. *J Virol.* 2006 80:10109**

- First demonstration of AXL in Ebola cell entry.

**Strange DP *et al.* Axl promotes Zika virus entry and modulates the antiviral state of human Sertoli cells. *mBio* 2019 10:e01372.**

- Demonstration that bemcentinib blocks Zika virus infection in multicellular organoids by attenuating both viral entry and type I interferon antagonism.

# Published papers in 2019 registered on Pubmed for AXL and Fibrosis: 8

**Tutusaus *et al.*, (2019) Axl targeting abrogates experimental non-alcoholic steatohepatitis (NASH) progression, Cellular and Molecular Gastroenterology and Hepatology, In Press**

- Bemcentinib reduces inflammation and fibrosis in a diet induced model of Non Alcoholic Steato Hepatitis (NASH)
- Patients with advanced fibrosis and cirrhosis have elevated sAXL in circulation and AXL expression in liver biopsies.

**Landolt *et al.*, (2019) AXL targeting reduces fibrosis development in experimental unilateral ureteral obstruction. Physiol Rep**

- Unilateral ureteric obstruction by ligation in mice, induced tubulointerstitial fibrosis with enhanced expression of AXL on cells of the interstitium, tubules and glomeruli
- Bemcentinib reduced development of fibrosis and inflammation in obstructed kidneys

## Reviews

- **Bellan M, *et al.* (2019) Gas6/TAM System: A Key Modulator of the Interplay between Inflammation and Fibrosis. Int J Mol Sci**
- **Smirne C, *et al.* (2019) Gas6/TAM Signaling Components as Novel Biomarkers of Liver Fibrosis. Dis Markers.**

## COPD

**Fujino *et al.*, (2019) Sensing of apoptotic cells through Axl causes lung basal cell proliferation in inflammatory diseases. J Exp Med.**

- Continued AXL signaling results in basal cell hyperplasia and a dysfunctional epithelial barrier in trachea with pathology typical of chronic inflammatory pulmonary diseases.
- Genetic depletion of AXL allows resolution of inflammation with differentiation to ciliated epithelium

# Published papers in 2019 registered on Pubmed for AXL and Cancer: 122

**Pearson et al., (2019) AXL Inhibition Extinguishes Primitive JAK2 Mutated Myeloproliferative Neoplasm Progenitor Cells.' HemaSphere 3.**

- Inhibition of AXL with Bemcentinib preferentially kills early hemopoietic stem cells from patients with JAK2 mutated driven MPN

**Terry et al., (2019 Cancer Immunology Research) AXL Targeting Overcomes Human Lung Cancer Cell Resistance to NK- and CTL-Mediated Cytotoxicity, Cancer Immunology Research.**

- AXL drives tumor EMT and resistance to cytotoxic lymphocyte-mediated cell killing
- Bemcentinib sensitizes NSCLC tumor cells to lymphocyte mediated cell killing

**Cruz et al., (2019) Axl-mediated activation of TBK1 drives epithelial plasticity in pancreatic cancer. JCI Insight**

- AXL drives an epithelial plasticity program enhancing invasive and metastatic capacity via TBK1 in KRAS-mutant PDA

**Quinn et al., (Mol Cancer Ther.2019) Therapeutic Inhibition of the Receptor Tyrosine Kinase AXL Improves Sensitivity to Platinum and Taxane in Ovarian Cancer. Mol Cancer Ther.**

- AXL contributes to platinum and taxane resistance in ovarian cancer, and inhibition of AXL improves chemoresponse and accumulation of chemotherapy drugs

**Tanaka et al., (2019) Axl signaling is an important mediator of tumor angiogenesis, Oncotarget.**

- Bemcentinib decreases the secretion of pro-angiogenic factors and impairs functional properties of endothelial cells *in vitro* and *in vivo*

**Tsukita et al., (2019) Axl kinase drives immune checkpoint and chemokine signalling pathways in lung adenocarcinomas. Mol Cancer.**

- AXL positively correlates expressions of PD-L1 and CXCR6
- Bemcentinib decreased mRNA expressions of PD-L1 and CXCR6 in EGFR mutation-positive cell lines.

## Reviews

- Yan S, et al., AXL Receptor Tyrosine Kinase as a Therapeutic Target in Hematological Malignancies: Focus on Multiple Myeloma. Cancers (Basel). 2019
- Zhu C *et al.*, AXL receptor tyrosine kinase as a promising anti-cancer approach: functions, molecular mechanisms and clinical applications. Mol Cancer. 2019
- Arner EN *et al.*, Behind the Wheel of Epithelial Plasticity in KRAS-Driven Cancers. Front Oncol.
- Myers KV *et al.*, Targeting Tyro3, Axl and MerTK (TAM receptors): implications for macrophages in the tumor microenvironment. Mol Cancer.
- Niu ZS *et al.*, Role of the receptor tyrosine kinase Axl in hepatocellular carcinoma and its clinical relevance. Future Oncol

# References

## Bemcentinib:

Ludwig, K.F., *et al.*, (2017) 'Small molecule Axl inhibition targets tumor immune suppression and enhances chemotherapy in pancreatic cancer,' Epub ahead of print.

- Axl associated with poor outcomes in pancreatic cancer uniquely links drug resistance and immune evasion.
- Bemcentinib blocks aggressive traits of pancreatic cancer & enhances activity of gemcitabine.
- Bemcentinib drives tumour cell differentiation and provokes an immune stimulatory microenvironment. Treatment reduces expression of Arginase-1 a key player in immune-suppression.

Guo et al (2017) Axl inhibition induces the antitumor immune response which can be further potentiated by PD-1 blockade in the mouse cancer models, *Oncotarget*

- Axl inhibition via bemcentinib reprograms immunological microenvironment to increased proliferation and activation of CD4 and CD8
- Bemcentinib and PD-1 blockade act synergistically

## Mode of Action & Biomarkers

Haaland, G.S., *et al.*, (2017) 'Association of warfarin use with Lower overall cancer incidence among patients older than 50 years,' *JAMA Intern Med.*, Nov 6.

- Warfarin inhibits Axl signalling and Axl-mediated biological response at doses lower than those which mediate anti-coagulation effects.
- Retrospective analysis of a large population cohort demonstrates that patients on low dose Warfarin had a significantly lower incidence of cancer.

Aguilera, T.A. & Giaccia, A.J. (2017) 'Molecular Pathways: Oncologic Pathways and Their Role in T-cell Exclusion and Immune Evasion-A New Role for the AXL Receptor Tyrosine Kinase,' *Clin. Cancer Res.*, June 15th.

- Immune checkpoint inhibitors are most effective against T-cell inflamed tumours. Non-T-cell or T-cell excluded tumours remain a significant barrier to treatment.
- Axl identified as a key mediator of immune evasion and experimental evidence demonstrates Axl targeting leads to greater anti-tumour immune response post radiotherapy.

Miller, M.A., *et al.*, (2017) 'Molecular Pathways: Receptor Ectodomain Shedding in Treatment, Resistance, and Monitoring of Cancer,' *Clin. Cancer Res.*, Feb 1.

- Proteases known as sheddases cleave the extracellular domain of several receptor tyrosine kinases such as Axl generating soluble Axl (sAxl).
- Plasma levels of sAxl are predictive of patient response to standard of care BRAF & MEK inhibitor therapy and could be used for patient stratification strategies.

Antony et al (2017) The GAS6-AXL signaling network is a mesenchymal (Mes) molecular subtype-specific therapeutic target for ovarian cancer. *Science Signalling*

- Axl particularly abundant in ovarian cancer subtype designated as mesenchymal (Mes)
- Axl co-clustered cMET, EGFR, and HER2, producing sustained extracellular signal-regulated kinase (ERK) activation in Mes cells
- Bemcentinib reduced tumor growth in chick chorioallantoic membrane model.

Kanzaki, R., *et al.*, (2017) 'Gas6 derived from cancer-associated fibroblasts promotes migration of Axl-expressing lung cancer cells during chemotherapy,' *Nature Scientific Reports*, Sept 6th.

- Tumor stroma microenvironment (TME) is comprised of cancer-associated fibroblasts (CAFs) which influence cancer cells such as non-small cell lung cancer (NSCLC).
- In a murine model, NSCLC treated with cisplatin induced an up-regulation of Gas6.
- NSCLC line H1299 migrated in response to Gas6.
- The CAF cell line LCAFhert expresses GAS6 and can promote H1299 cell migration.
- Conclusion- CAF derived GAS6 promotes migration of Axl-expressing lung cancers.

## Reviews

Levin et al (2016) Axl Receptor Axis: A New Therapeutic Target in Lung Cancer. *J Thoracic Oncol*

Chouaib et al (2014) Tumor Plasticity Interferes with Anti-Tumor Immunity. *Critical Reviews in Immunology*

Gay et al (2017) Giving AXL the axe: targeting AXL in human malignancy. *BJC*

Brown et al (2016) Gene of the month: Axl. *BMJ*

Halmos et al (2016) New twists in the AXL(e) of tumor progression. *Science Signalling*

# References

## Resistance

**Zucca, L.E., et al., (2017) 'Expression of tyrosine kinase receptor AXL is associated with worse outcome of metastatic renal cell carcinomas treated with sunitinib,' *Urol Oncol.*, Oct 3.**

- Renal cell carcinoma (RCC) represents 2-3% of all cancers in the Western world.
- First line therapy is sunitinib (PDGF/VEGF TK inhibitor).
- 47% of RCC patients treated with sunitinib were +ve for Axl.
- Axl expression in sunitinib treated patients correlated with worse clinical outcome (13 months Vs 43 months survival).

**Husain, H., et al., (2017) 'Strategies to Overcome Bypass Mechanisms Mediating Clinical Resistance to EGFR Tyrosine Kinase Inhibition in Lung Cancer,' *Mol. Cancer Ther.*, Feb 2017.**

- Patient treated with EGFR based therapies develop resistance via multiple mechanisms.
- Resistant metastatic lung cancers exhibit increased AXL, EMT and PDL1 expression.

**Elkabets et al (2015) AXL Mediates Resistance to PI3Ka Inhibition by Activating the EGFR/PKC/mTOR Axis in Head and Neck and Esophageal Squamous Cell Carcinomas. *Cancer Cell***

- Axl mediates persistent mTOR activation and upregulated in resistant tumors
- Combined treatment with PI3Ka and either EGFR, AXL, or PKC inhibitors reverts this resistance

**Mak et al (2015) A patient-derived, pan-cancer EMT signature identifies global molecular alterations and immune target enrichment following epithelial to mesenchymal transition. *Clin Cancer Res***

- EMT signature was developed based on 11 tumor types
- Axl frequently overexpressed in EMT tumors along with PD-L1, PD1, CTLA4, OX40L, and PDL2
- highlights the possibility of utilizing EMT status--independent of cancer type--as an additional selection tool to select patients who may benefit from immune checkpoint blockade

**Zhang et al (2012) Activation of the AXL kinase causes resistance to EGFR targeted therapy in lung cancer. *Nature Genetics***

**Mueller et al (2014) Low MITF/AXL ratio predicts early resistance to multiple targeted drugs in melanoma**

- high Axl in melanoma cells correlates with drug resistance
- BRAF and ERK inhibitors are more effective when using Axl inhibition

# References

## Non-Oncology

### Pulmonary fibrosis

**Fujino N. et al., (2017) Phenotypic screening identifies Axl kinase as a negative regulator of an alveolar epithelial cell phenotype. *Lab Invest.* 2017 Sep;97(9):1047-1062.**

- Axl was activated in hyperplasia of epithelial cells in idiopathic pulmonary fibrosis patients where the epithelial barrier integrity was lost
- In vitro, Axl inhibition or downregulation by small interfering RNA led to increase in epithelial surfactant protein expression and promotion of an epithelial cell phenotype.

**Espindola, M. S. et al., (2018) Targeting of TAM Receptors Ameliorates Fibrotic Mechanisms in Idiopathic Pulmonary Fibrosis. *Am J Respir Crit Care Med* 197, 1443–1456.**

- IPF patients with high expression of Axl are rapid (declining lung function) progressors.
- Bemcentinib inhibited the fibrogenic phenotype of IPF patient derived fibroblasts.
- GAS6 knockout animals were protected from Bleomycin induced lung fibrosis (Gold standard model of pulmonary fibrosis).
- Bemcentinib inhibited the development of fibrosis in the IPF SCID mouse model (Human IPF fibroblasts induce pulmonary fibrosis in the SCID mouse).

### Chronic Obstructive Pulmonary Disease

**Fujino, N. et al., (2019) Sensing of apoptotic cells through Axl causes lung basal cell proliferation in inflammatory diseases. *J Exp Med* 216, 2184–2201.**

- Basal epithelial cells in the trachea, express AXL and are activated by Gas6 ligand interaction with apoptotic cells in airway inflammation.
- AXL signaling is critical for expansion of the pool of basal cells, but needs to be silenced to allow differentiation of basal epithelium ciliated cell regeneration.
- Continued AXL signaling results in basal cell hyperplasia and a dysfunctional epithelial barrier with abnormal differentiation to squamous (not ciliated) epithelium and continued cell turnover, typical of the pathology of chronic inflammatory pulmonary diseases.
- Genetic depletion of AXL allows resolution of inflammation with differentiation to ciliated epithelium

### Liver Fibrosis

**Stauffer K., et al., (2017) ‘The non-invasive serum biomarker soluble Axl accurately detects advanced liver fibrosis and cirrhosis,’ *Cell Death Dis.* Oct 26.**

- sAxl confirmed to be accurate biomarker of liver fibrosis and cirrhosis.
- sAxl/albumin demonstrated to be further enhancing as a cheap and accurate biomarker.

**Barcena et al (2015) Gas6/Axl pathway is activated in chronic liver disease and its targeting reduces fibrosis via hepatic stellate cell inactivation. *J Hepatology*, Sep;63(3):670-8**

- Axl levels paralleled HSC activation
- Axl knock out mice displayed decreased HSC activation in vitro and liver fibrogenesis after chronic damage by CCl4 administration
- Bemcentinib reduced collagen deposition and CCl4-induced liver fibrosis in mice

**Tutusaus et al., (2019) Axl targeting abrogates experimental non-alcoholic steatohepatitis (NASH) progression, *Cellular and Molecular Gastroenterology and Hepatology*, In Press**

- Bemcentinib reduces inflammation and fibrosis in a diet induced model of Non Alcoholic Steato Hepatitis (NASH)
- Patients with advanced fibrosis and cirrhosis have elevated sAXL in circulation and AXL expression in liver biopsies.

### Kidney fibrosis

**Landolt, L. et al., (2019) AXL targeting reduces fibrosis development in experimental unilateral ureteral obstruction. *Physiol Rep* May;7(10):e14091**

- Progressive chronic kidney disease is typified by kidney fibrosis, typified by activated myofibroblast accumulation and deposition of extracellular matrix.
- Unilateral ureteric obstruction by ligation, in mice, induced tubulointerstitial fibrosis with enhanced detection of AXL on cells of interstitium, tubules and glomeruli
- Bemcentinib reduced development of fibrosis and inflammation in obstructed kidneys compared to treatment with an ACE-inhibitor

### Polycythaemia Vera, Myelofibrosis (MyeloProliferative Neoplasms - MPN)

**Pearson, S. et al., (2019) ‘AXL Inhibition Extinguishes Primitive JAK2 Mutated Myeloproliferative Neoplasm Progenitor Cells,’ *HemaSphere* 3.**

- AXL is upregulated and activated in JAK2 associated MPNs
- Inhibition of AXL with Bemcentinib preferentially kills early hemopoietic stem cells from patients and, as such represents a promising therapeutic approach for JAK2 driven MPN

### Reviews

**Bellán M, et al. (2019) Gas6/TAM System: A Key Modulator of the Interplay between Inflammation and Fibrosis. *Int J Mol Sci.* Oct 12;20(20)**

**Smirne C, et al. (2019) Gas6/TAM Signaling Components as Novel Biomarkers of Liver Fibrosis. *Dis Markers.* Sep 8;2019:2304931.**