



ASGCT 2020

Fabry & Cystinosis Data Update

May 13, 2020

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observed from preclinical or clinical trials, will not be replicated or will not continue in ongoing or future studies or trials involving AVROBIO’s investigational gene therapies, the risk that we will be unable to obtain and maintain regulatory approvals for our investigational gene therapies, the risk that the size and growth potential of the market for our investigational gene therapies will not materialize as expected, risks associated with our dependence on third-party suppliers and manufacturers, risks regarding the accuracy of our estimates of expenses and future revenue, risks relating to our capital requirements and needs for additional financing, risks relating to clinical trial and business interruptions resulting from the COVID-19 outbreak or similar public health crises, including that such interruptions may materially delay our development timeline and/or increase our development costs or that data collection efforts may be impaired or otherwise impacted by such crises, and risks relating to our ability to obtain and maintain intellectual property protection for our investigational gene therapies. For a discussion of these and other risks and uncertainties, and other important factors, any of which could cause AVROBIO’s actual results to differ from those contained in the forward-looking statements, see the section entitled “Risk Factors” in AVROBIO’s most recent Quarterly Report on Form 10-Q, as well as discussions of potential risks, uncertainties and other important factors in AVROBIO’s subsequent filings with the Securities and Exchange Commission. AVROBIO explicitly disclaims any obligation to update any forward-looking statements except to the extent required by law.

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ASGCT 2020 data update – key takeaways



New data show consistent results across Fabry disease and cystinosis programs

Long-term Fabry patient data

Sustained long-term positive trends

- Patient 1 in the Phase 2 trial continues to show stable leukocyte and plasma AGA enzyme activity, now out 22 months
- Patient 3 in the Phase 2 trial shows increased leukocyte and plasma AGA enzyme activity, decreased plasma lyso-Gb3 level, and stable VCN at new time points
- All three Phase 1 patients off ERT remain off ERT

First Fabry plato™ patient

plato continues to perform

- One-month plasma lyso-Gb3 decrease of 43% vs. baseline
- Three-month leukocyte and plasma enzyme activity levels 3x greater than mean of other three patients at same timepoint in Phase 2 trial
- Rapid neutrophil and platelet recovery with minimal lymphocyte depletion post Bu90 conditioning

Cystinosis Patient 1 data





Positive trends at six months, including kidney function measures

- eGFR and serum creatinine measures trending positively at 6 months
- Pill burden remains significantly lower than at baseline

Multiple programs in the clinic

10 patients dosed to date



Investigational Gene Therapy		Proof-of-Concept	IND-Enabling	Phase 1/2	Commercial Rights
Fabry AVR-RD-01		Phase 2			AVROBIO
Gaucher AVR-RD-02		Phase 1/2			AVROBIO
Cystinosis AVR-RD-04		Phase 1/2			AVROBIO
Pompe AVR-RD-03		Preclinical			AVROBIO



Fabry Disease



AVR-RD-01



Goals for gene therapy in Fabry disease

UNMET NEEDS:



Kidney function

Unmet needs: proteinuria, polyuria, kidney failure



Cardiac function

Unmet needs: left ventricular hypertrophy, fibrosis, heart failure



Neuropathic pain

Unmet needs: pain and burning sensations in hands and feet, pain crises



CNS complications

Unmet needs: TIA/stroke, depression, impaired executive function, white matter hyperintensities



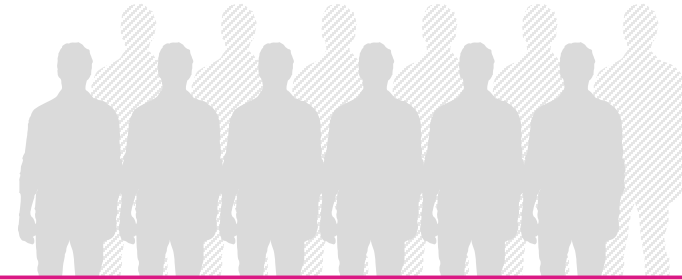
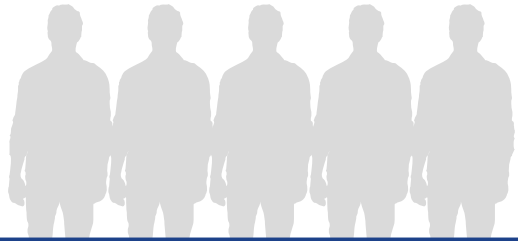
Everyday burden of illness and life expectancy

Unmet needs: fatigue, inability to sweat, joint pain, abdominal pain, diarrhea, vomiting, cloudy vision, hearing loss, tinnitus, rash, angiokeratomas, biweekly infusions, shortened lifespan



Two AVR-RD-01 Fabry clinical trials

9 patients dosed across Phases 1 and 2



PHASE 1

Investigator-Sponsored Trial*

Patients

n = 5 (fully enrolled)
On ERT > 6 months prior to enrollment
18-50 year-old males

Key Objective

Safety and preliminary efficacy

PHASE 2

AVRO – FAB-201 Trial

Patients

n = 8-12 (4 patients dosed to-date)
Treatment-naïve
16-50 year-old males

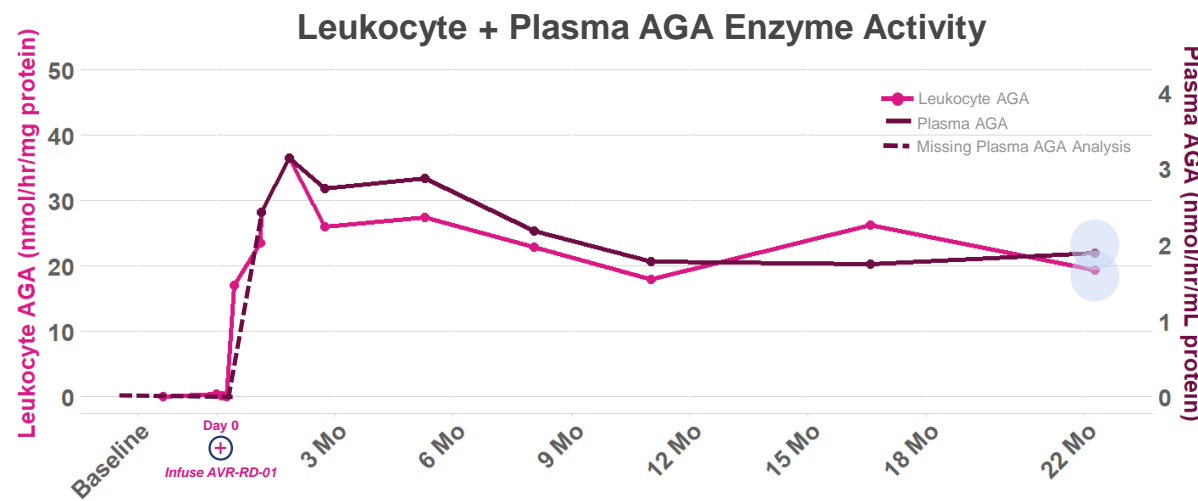
Key Objectives

Safety and efficacy

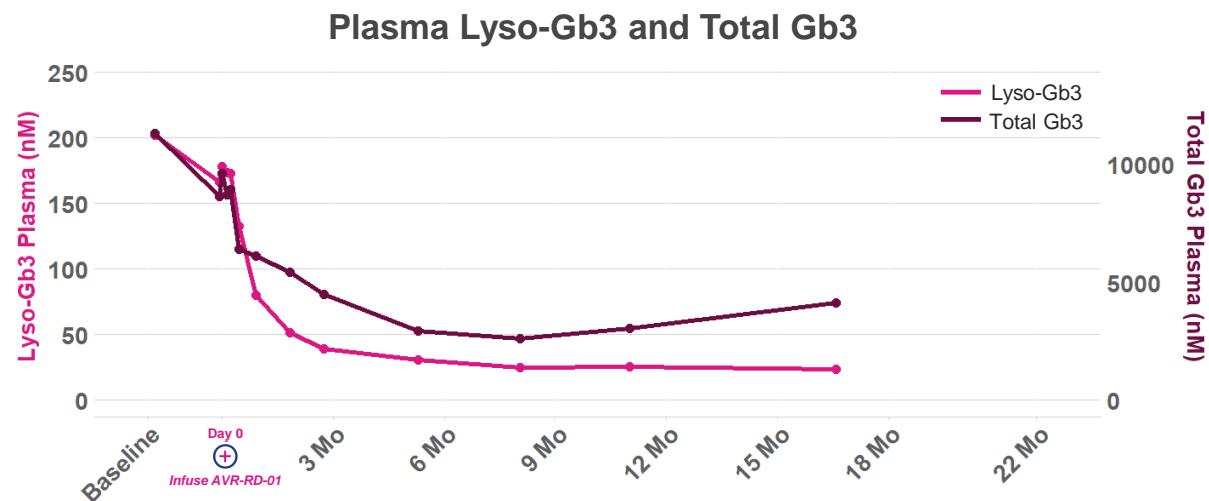
* Sponsored by FACTs team (Fabry Disease Clinical Research and Therapeutics) in Canada



Patient 1: Multiple data trends sustained up to 22 months



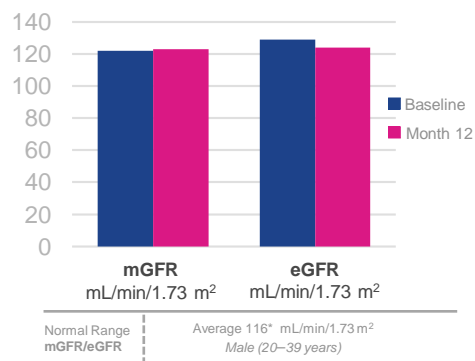
*Lab A: Mayo Clinic Laboratories; Lab B: Rutar Laboratory; Lab A Reference Range: >23.1 nmol/hr/mg; Lab B Reference Range: 24–56 nmol/hr/mg
†Reference Range: 5.1–9.2 nmol/hr/mL; AGA: α-galactosidase A



*Reference Value: 2.4 nM; †Reference Value: 4961 nM; 6012 nM before August 2018 (until Day 28 for Patient 1)
Lyso-Gb3: Globotriaosylsphingosine; Gb3: Globotriaosylceramide

KIDNEY FUNCTION

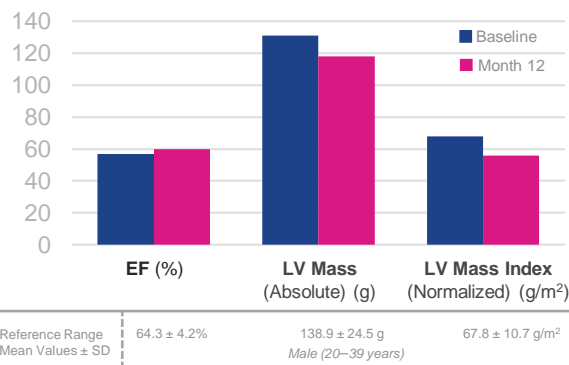
remains within normal range at 12 mos.



*Source: <https://www.kidney.org/atoz/content/gfr>
mGFR: Measured Glomerular Filtration Rate; eGFR: Estimated Glomerular Filtration Rate

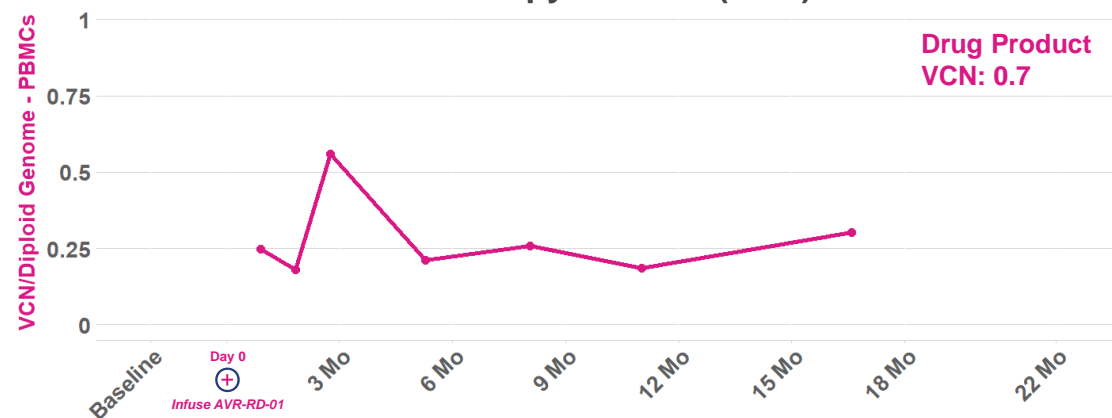
CARDIAC FUNCTION

remains within normal range at 12 mos.



Source: Allakhi K et al, J Magn Reson Imaging, 2003
EF: Ejection Fraction; LV: Left Ventricular

Vector Copy Number (VCN)



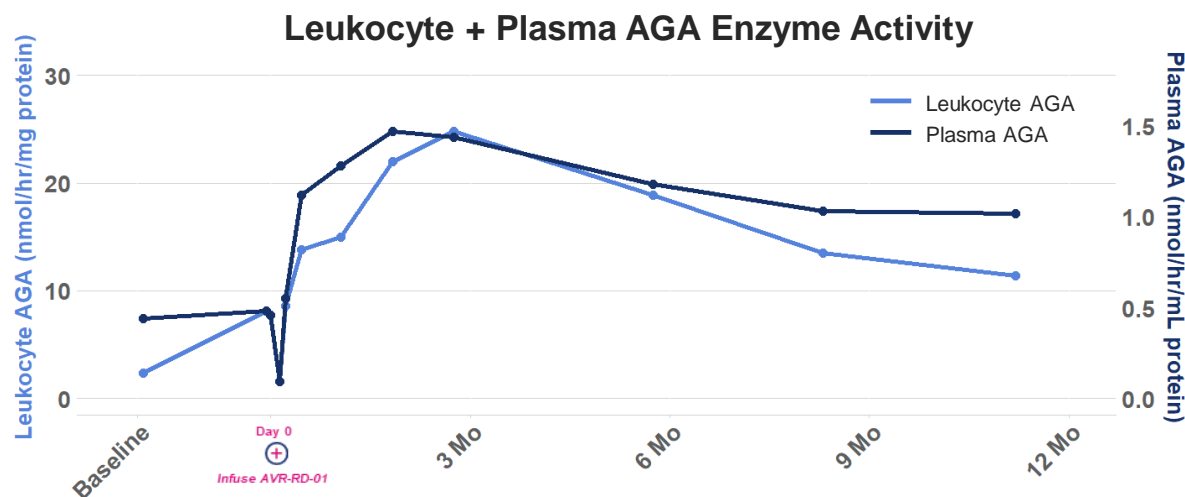
VCN: Vector Copy Number; PBMCs: Peripheral Blood Mononuclear Cells

Note: Patient #1 had a skin biopsy score of 3 (severe accumulation) at baseline, a score of 2 (moderate accumulation) at 6 months and a score of 1 (mild accumulation) at 12 months

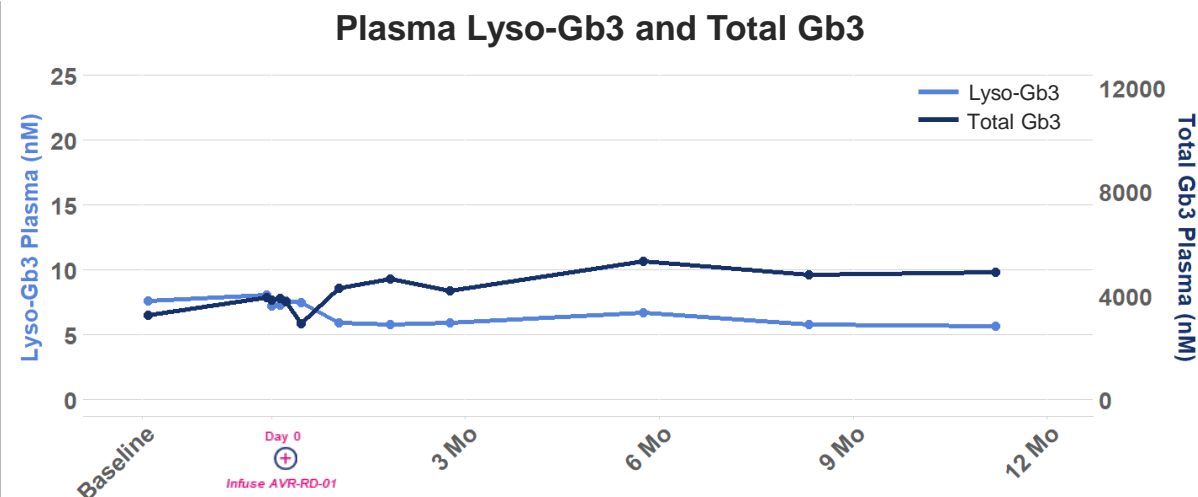
Note: Visualization of multiple biomarkers adjusted to utilize the same statistical scaling ratio across biomarkers (as compared to prior presentation)



Patient 2: Multiple data trends sustained up to 1 year*

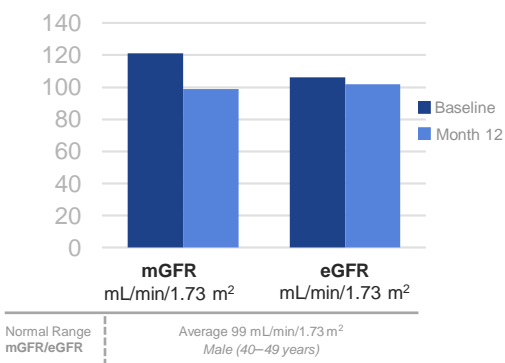


*Data from Rutar Laboratory; Reference Range: 24–56 nmol/hr/mg; †Reference Range: 5.1–9.2 nmol/hr/mL; AGA: α -galactosidase A



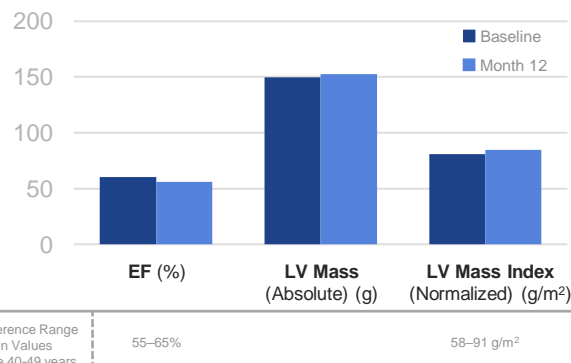
*Reference Value: 2.4 nM; †Reference Value: 4961 nM; Note: Patient #2 has normal substrate, consistent with late-onset cardiac variant phenotype
Lyso-Gb3: Globotriaosylsphingosine; Gb3: Globotriaosylceramide

KIDNEY FUNCTION remains within normal range



Source: <https://www.kidney.org/atoz/content/gfr>
mGFR: Measured Glomerular Filtration Rate; eGFR: Estimated Glomerular Filtration Rate

CARDIAC FUNCTION remains within normal range



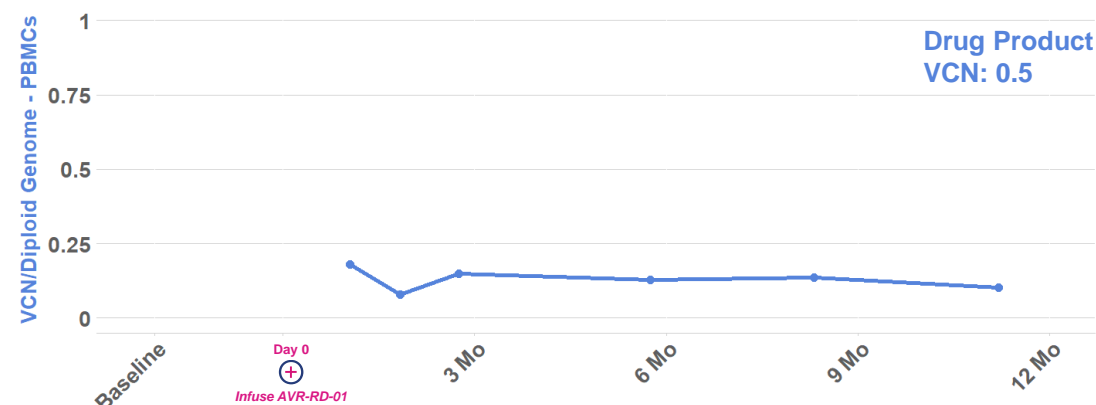
Source: Alfakih K et al, J Magn Reson Imaging, 2003
EF: Ejection Fraction; LV: Left Ventricular

Note: As patient #2 is a cardiac variant of Fabry disease, this patient had a skin biopsy score of 0 (trace or no accumulation) at baseline and at 6 months

Note: Visualization of multiple biomarkers adjusted to utilize the same statistical scaling ratio across biomarkers (as compared to prior presentation)

* Latest data points for this patient are at the 1-year follow-up which = 48 weeks per protocol

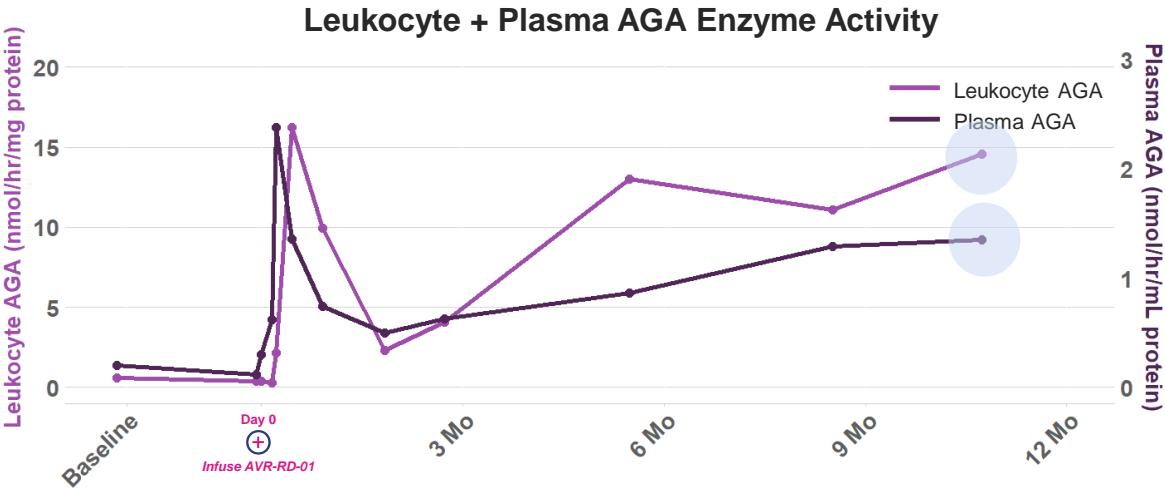
Vector Copy Number (VCN)



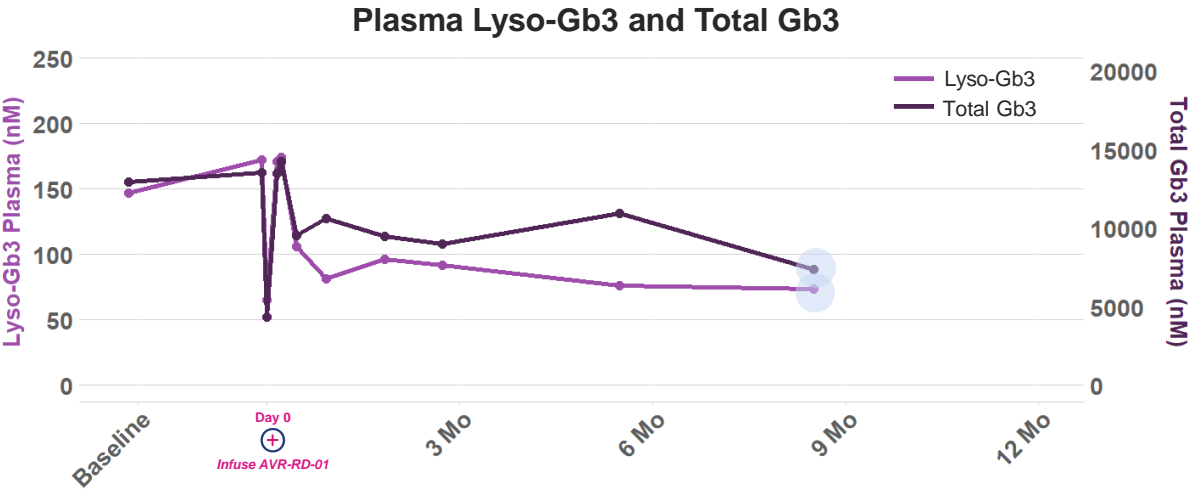
VCN: Vector Copy Number; PBMCs: Peripheral Blood Mononuclear Cells



Patient 3: Data up to 1 year* suggest trend towards durable engraftment



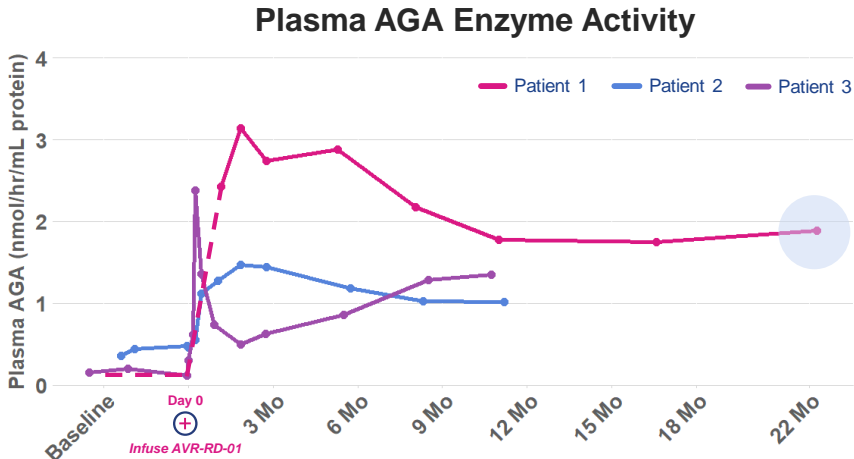
*Data from Rupar Laboratory; Reference Range: 24–56 nmol/hr/mg; †Reference Range: 5.1–9.2 nmol/hr/mL; AGA: α-galactosidase A



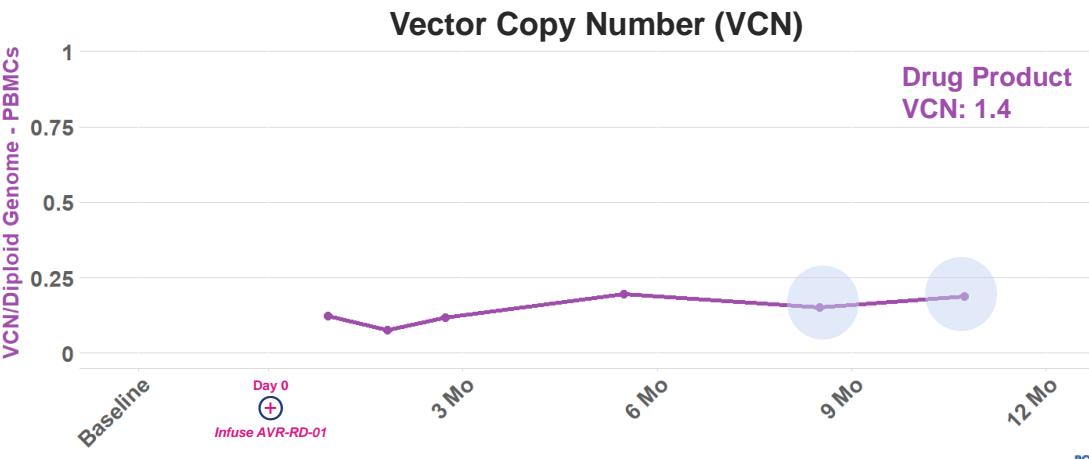
*Reference Value: 2.4 nM; †Reference Value: 4961 nM; Lyso-Gb3: Globotriaosylsphingosine; Gb3: Globotriaosylceramide

Skin Biopsy Score (Patient 3)

Baseline	2
6 months	2



Reference Range: 5.1–9.2 nmol/hr/mL; AGA: α-galactosidase A



VCN: Vector Copy Number; PBMCs: Peripheral Blood Mononuclear Cells

Note: Visualization of multiple biomarkers adjusted to utilize the same statistical scaling ratio across biomarkers (as compared to prior presentation)
*1-year follow-up = 48 weeks per protocol



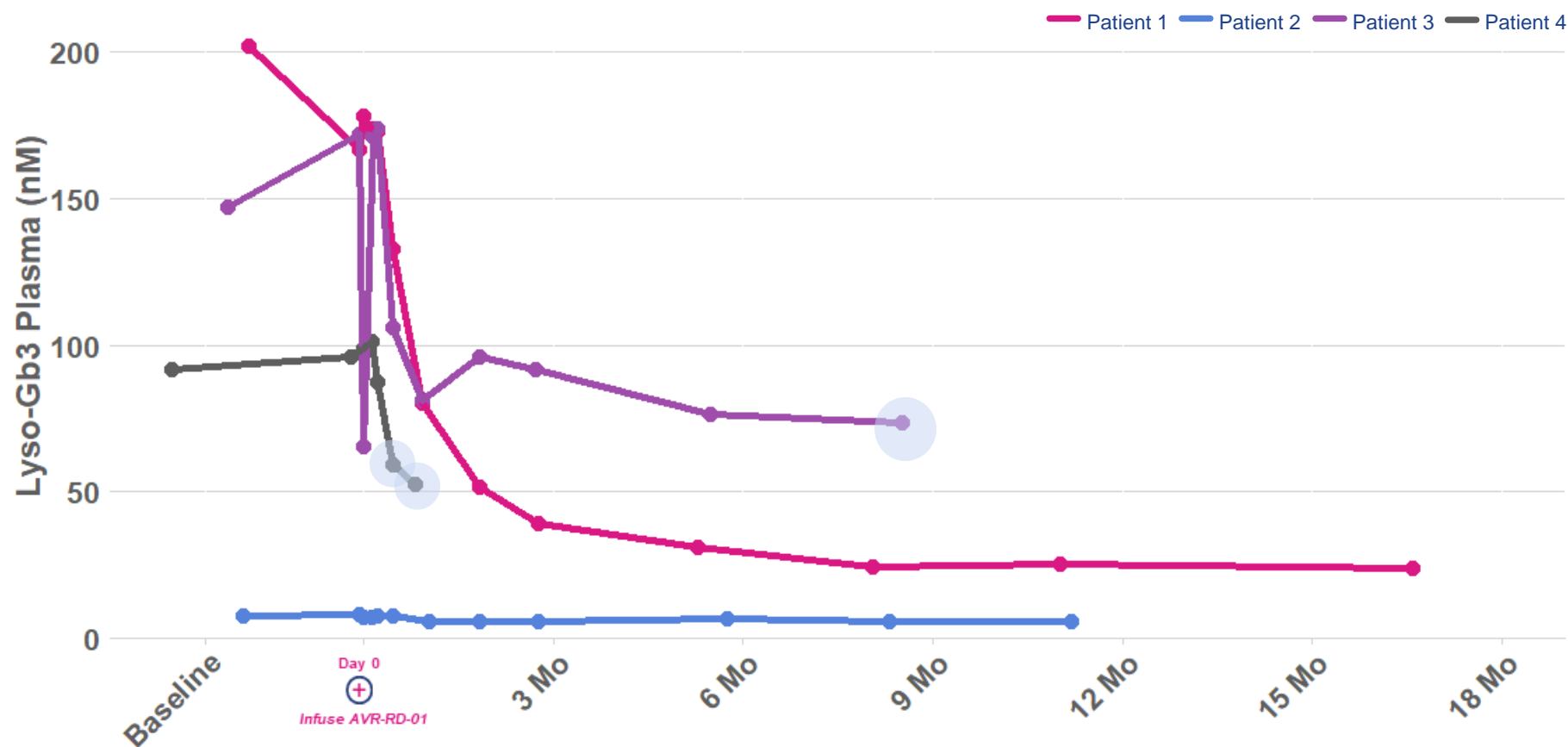
Patients 1-4: Plasma and leukocyte enzyme activity sustained up to 22 months

Patient #4 dosed using plato™





Patients 1-4: Plasma lyso-Gb3 reduction sustained up to 18 months



Reduction from Baseline to Last Observation

Patient 1 88%

Patient 2 NA

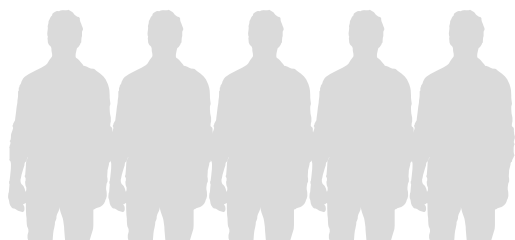
Patient 3 50%

Patient 4 43%

- Lyso-Gb3: Globotriaosylsphingosine
- Note: Patient #2 has normal substrate, consistent with late-onset cardiac variant phenotype

Two AVR-RD-01 Fabry clinical trials

9 patients dosed across Phases 1 and 2



PHASE 1

Investigator-Sponsored Trial*

Patients

n = 5 (fully enrolled)
On ERT > 6 months prior to enrollment
18-50 year-old males

Key Objectives

Safety and preliminary efficacy



PHASE 2

AVRO – FAB-201 Trial

Patients

n = 8-12 (4 patients dosed to-date}
Treatment-naïve
16 - 50 year-old males



Key Objectives

Safety and efficacy

FAB-201 = AVRO-RD-01-201 Study

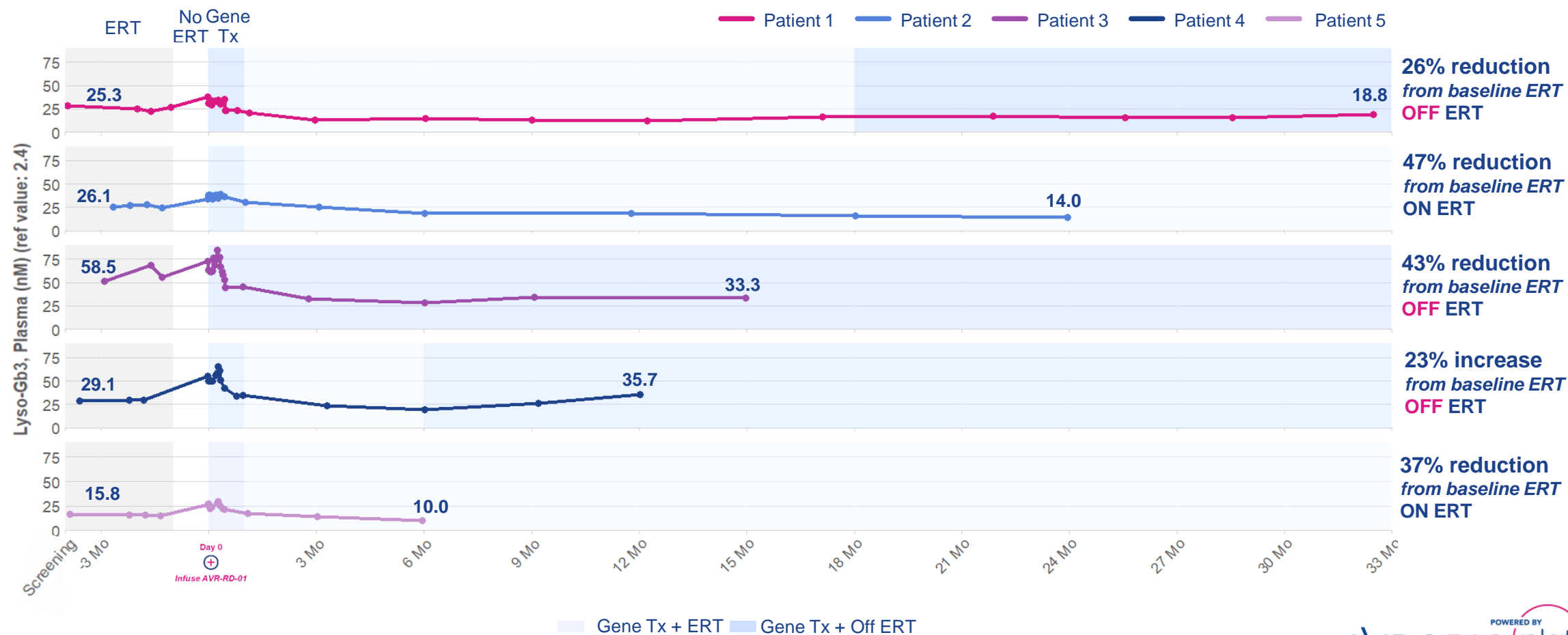
* Sponsored by FACTs team (Fabry Disease Clinical Research and Therapeutics) in Canada

ERT: Enzyme Replacement Therapy



Patients 1-5: Plasma lyso-Gb3 reduction sustained up to 32 months

All patients who have discontinued ERT remain off ERT*



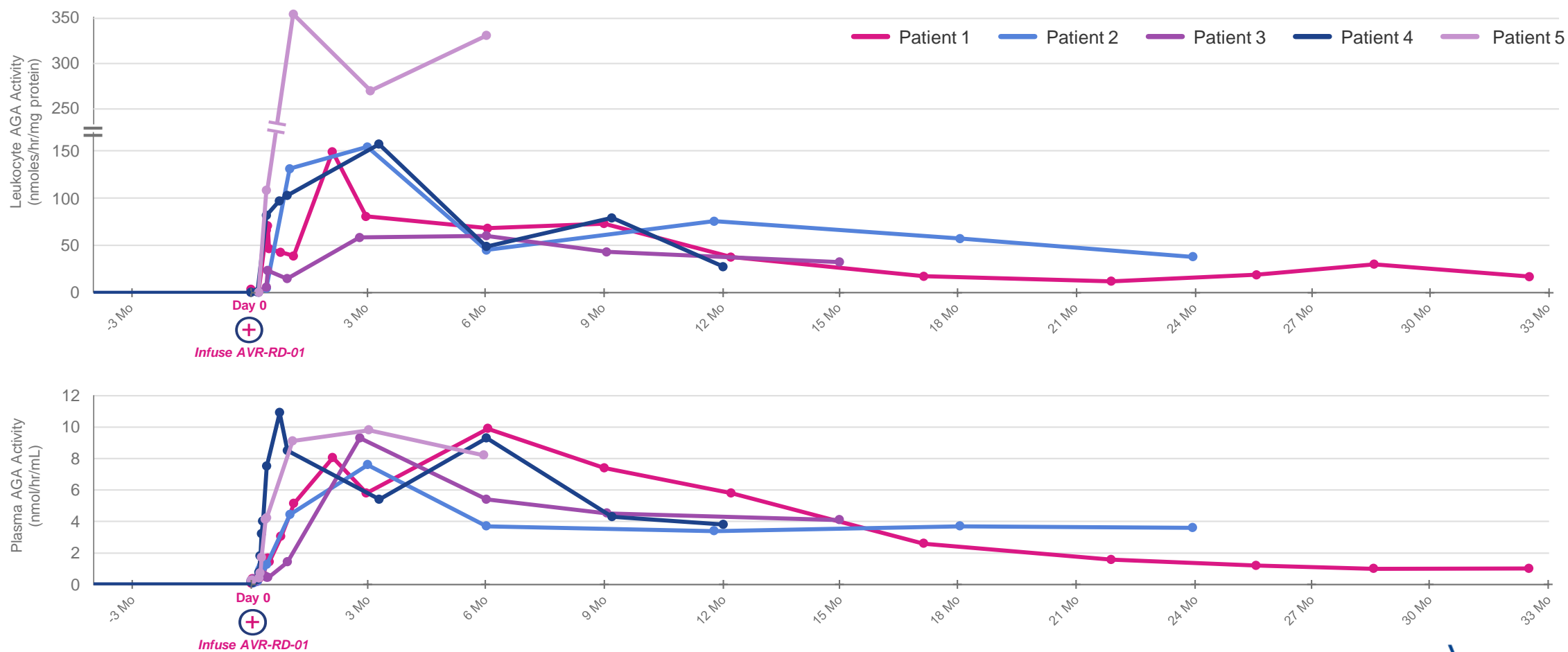
* As of April 27, 2020 (update)

Lyso-Gb3: Globotriaosylsphingosine; ERT: Enzyme Replacement Therapy; Tx: Therapy



Patients 1-5: Leukocyte and plasma enzyme activity sustained up to 32 months

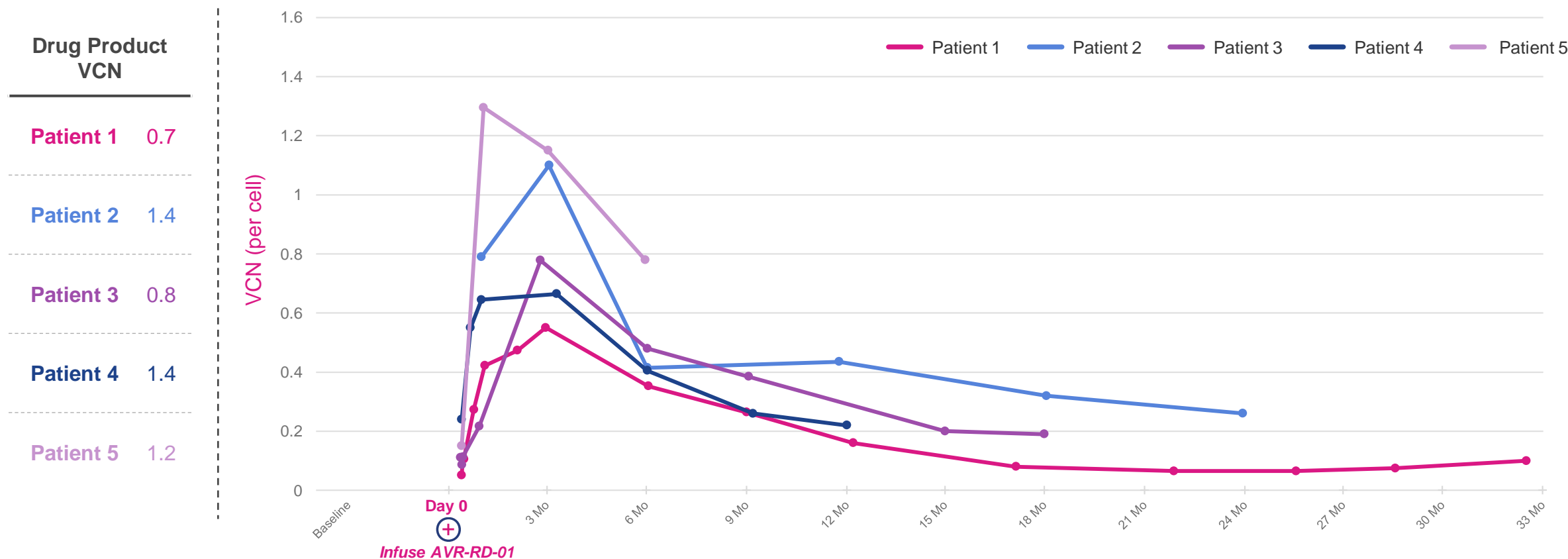
Consistent trends across all patients, 4 patients > 1 year





VCN stable at 32 months with consistent trend across all other patients

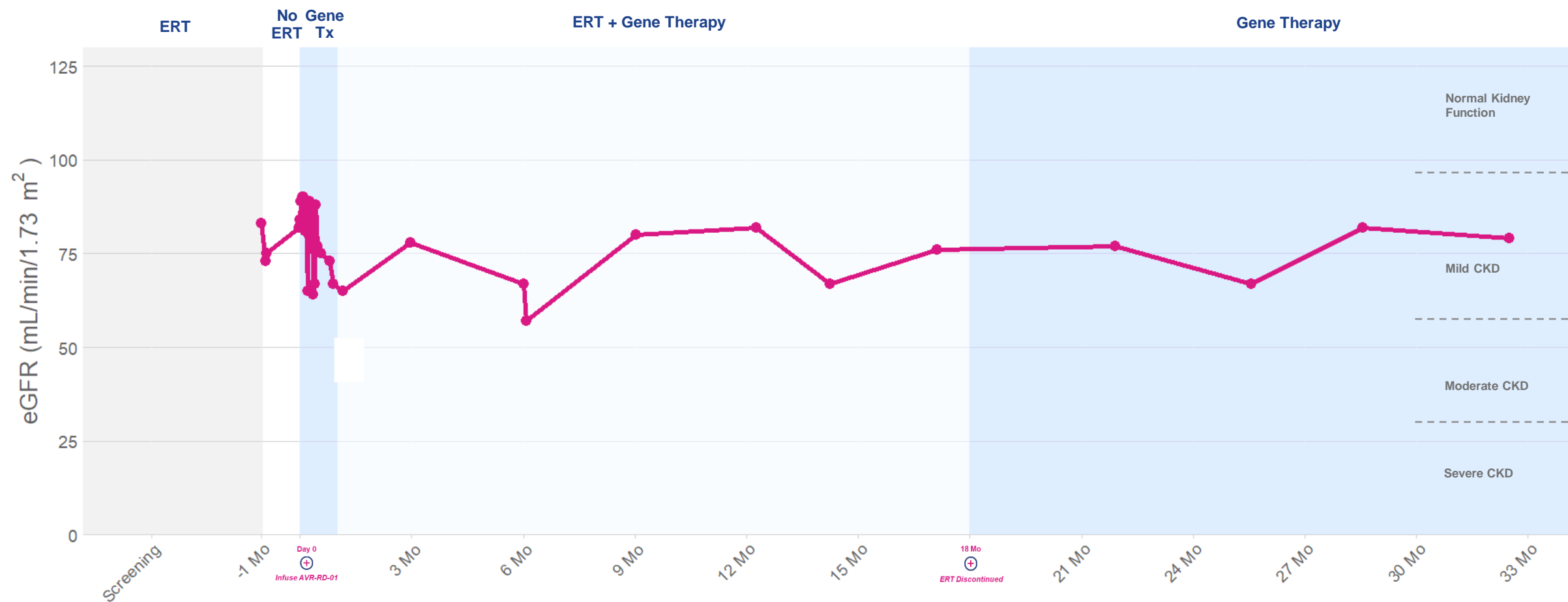
4 patients with 1+ years data



Note: 0.1 VCN is indicative of approx. 5-10% of all nucleated cells having an average of 1-2 copies of the transgene
VCN: Vector Copy Number



Patient 1: Kidney function stable at 32 months



eGFR: Estimated Glomerular Filtration Rate; ERT: Enzyme Replacement Therapy; TX: Therapy; CKD: Chronic Kidney Disease



Phase 1 Fabry (5 patients) and
FAB-201 (4 patients)

**No unexpected
safety events
or trends
identified**



No SAEs related to AVR-RD-01 drug product



AEs and SAEs reported

Phase 1 AEs (n = 128):

- Generally consistent with myeloablative conditioning, underlying disease or pre-existing conditions

FAB 201 AEs (n = 98):

- Generally consistent with myeloablative conditioning, underlying disease or pre-existing conditions
 - Grade 1 or 2 (n = 72)
 - Grade 3 or 4 (n = 30)

Phase 1 SAEs (n = 2):

- Febrile neutropenia (grade 3)
- Thrombophlebitis (grade 2)

FAB 201 SAEs: (n = 4)

Pre-treatment and prior to conditioning

- Seizure (grade 2)

Post-treatment

- Dehydration, nausea, vomiting (grade 3)
- Febrile neutropenia (2 patients, grade 3 & 4)



Anti-AGA antibodies

- Pre-existing low titers detected in 4 patients

Note: Safety data cut November 26, 2019

AE: Adverse Event; SAE: Serious Adverse Event

NOTE: AVR-RD-01 is an investigational gene therapy



Cystinosis



AVR-RD-04



Goals for gene therapy in cystinosis

UNMET NEEDS:



Kidney function

Unmet needs: renal Fanconi syndrome, proteinuria, chronic kidney disease, kidney failure



Vision

Unmet needs: corneal cystine accumulation, photophobia, involuntary eyelid closure



Endocrine disorders

Unmet needs: softening/weakening of bones, bone pain, rickets, long bone deformations, hypophosphatemia, delayed growth, hypothyroidism, pancreatic insulin insufficiency, diabetes, infertility



CNS complications

Unmet needs: myopathy, hypotonia, tremors, difficulty swallowing, neurodevelopmental issues (speech and walking delay and cognitive impairment)



Everyday burden of illness and life expectancy

Unmet needs: medications multiple times per day that cause GI discomfort and sulfur body and breath smell, shortened lifespan

Investigator-sponsored* study of AVR-RD-04 in cystinosis patients

First patient dosed



PHASE 1/2

Investigator-Sponsored Trial*



Patients

Up to 6 patients

Adults and adolescents

Cohorts 1-2 ≥ 18 years; Cohort 3 ≥ 14 years

Male and Female

On oral and ophthalmic cysteamine

Key Objectives

Safety and efficacy

* Sponsored by University of California, San Diego
Note: AVR-RD-04 aka CTNS-RD-04



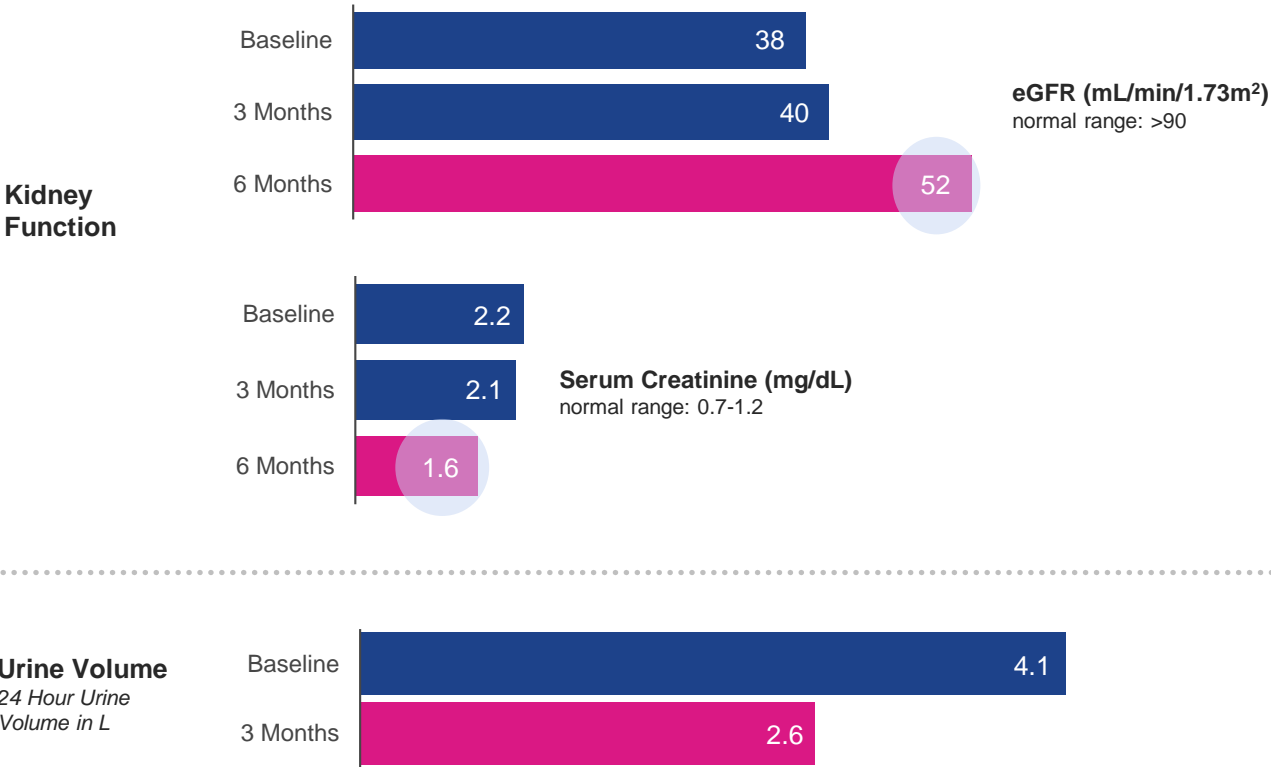
Cystinosis AVR-RD-04 Phase 1/2 Patient Characteristics

	PATIENT 1
Age of symptom onset / diagnosis	0 year / 8 months
Age dosed with AVR-RD-04	20 years
Gender	Male
Mutation	Allele 1: LDM ₁ Allele 2: Nt1035 (insC)
Primary disease signs and SoC treatment related symptoms, including	<ul style="list-style-type: none">• Fanconi syndrome• Polyuria• Corneal abnormalities• Mild photophobia• Vomiting
Granulocyte Cystine levels at baseline (nmol half cystine per mg protein)*	7.8
Comments	NO kidney transplant <ul style="list-style-type: none">• Cysteamine 1125 mg p.o. every 12 h/day since 2009; discontinued prior to AVR-RD-04 infusion• Cysteamine eyedrops 4-5x/day• Concomitant medications not listed



Patient 1: Initial data indicate positive trends across multiple measures

CLINICAL LAB MEASURES



BIOMARKER ENDPOINTS



- Experimental *in vivo* confocal microscopy
- Two skin areas, behind the ear and 'optional', averaged
- Analysis and quantification (3D Image-Pro software)

VCN
(vcn/dg)
(Drug Product = 2.1)

Measure	Value
1 Month	2.9
2 Months	3.0
3 Months	2.0

Average Granulocyte Cystine Level
(μmol half cystine/g protein)

Measure	Value
Baseline	7.8
1 Month	1.3
2 Months	1.5
3 Months	1.5

Asymptomatic Heterozygous Carrier Granulocyte Cystine Range: 0.2 – 1.9 μmol half cystine/g protein
Source: Gertsman I et al., Clinical Chemistry, 2016
VCN: Vector Copy Number; CTNS: Cystinosis, Lysosomal Cystine Transporter; mRNA: Messenger Ribonucleic Acid; eGFR: Estimated Glomerular Filtration Rate; SCr: Serum Creatinine
*Data obtained using a novel experimental methodology utilizing in vivo confocal microscopy, to image crystals in the skin behind the ear



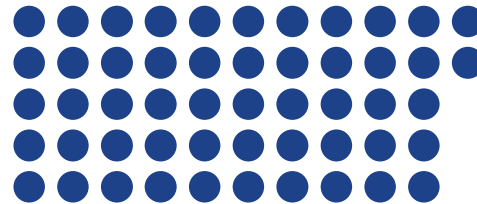
Patient 1: Reduced treatment burden at 6 months

Number of Medications and Supplements

(max per day)

**Before
Gene Therapy**

ON Cysteamine



52

**After Gene
Therapy**

(at 6 months
post-gene therapy)

OFF Cysteamine



20



Phase 1/2 Cystinosis
1 patient dosed

**No unexpected
safety events
or trends
identified**



No AEs or SAEs related to AVR-RD-04 drug product



No SAEs reported



AEs reported

- Consistent with myeloablative conditioning and underlying disease
- N = 22 (moderate = 9, mild = 13)

Pre-treatment and prior to conditioning (n = 6, not all events listed)

- Diarrhea, hypokalemia, dizziness
- Dehydration, vomiting

Post-treatment (n = 16, not all events listed)

- Alopecia, intermittent diarrhea, vomiting
- Mucositis, intermittent febrile neutropenia, intermittent epistaxis
- Intermittent blurry vision, intermittent hypokalemia, mucocoeles
- Thrombocytopenia



platoTM

—
AVROBIO's foundation designed to
scale gene therapy worldwide










*State-of-the-art technologies including
automated manufacturing platform*

+ Optimized
for performance

+ Redefines manufacturing
best practices

plato™: Three upgrades designed to optimize potency, safety and durability



 UPGRADES	Increase enzyme activity	Increase transduction efficiency	Increase VCN	Increase marrow space / engraftment	Increase consistency and safety
					
					 *
					
Upgrades designed to increase Vector Copy Number (VCN), enzyme activity, chimerism and durability					

* TDM (therapeutic drug monitoring)

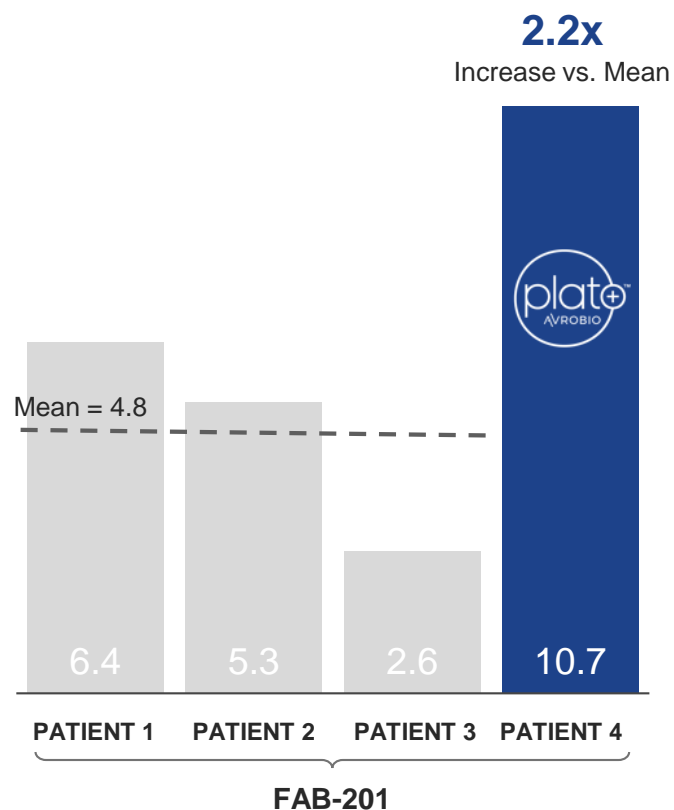


VECTOR UPGRADE:

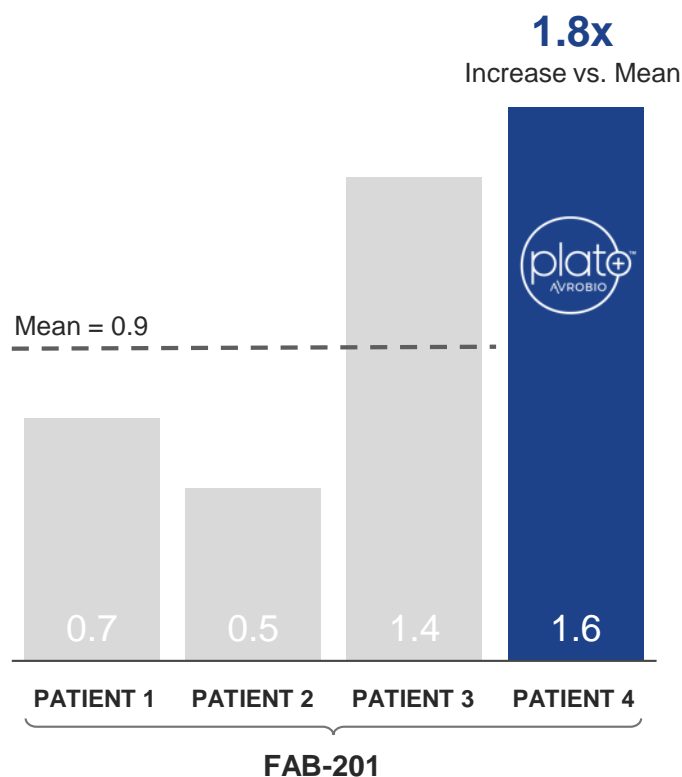
Metrics compared to academic process

FAB-201 patient #4 drug product data with plato™

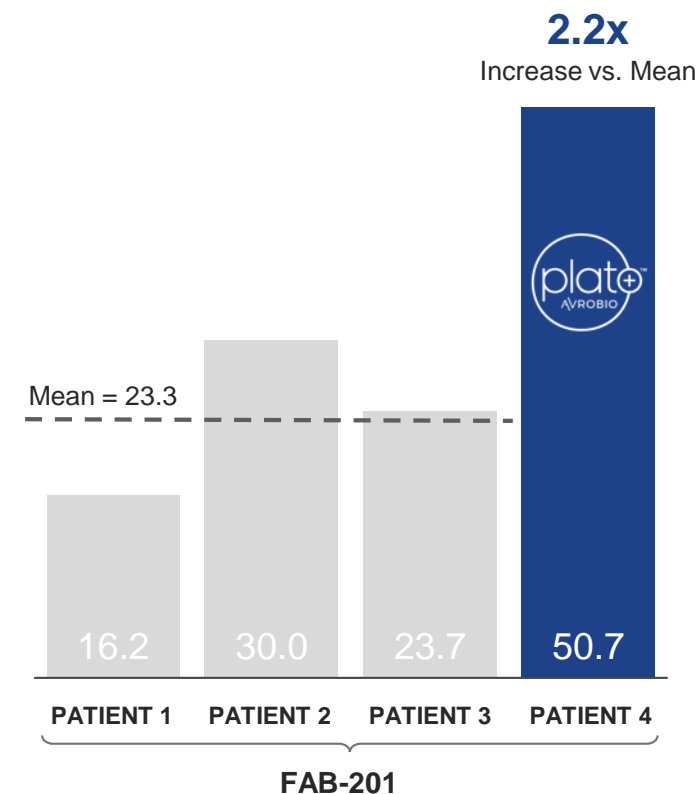
Enzyme Activity (nmol/hr/mL)



VCN (per diploid genome)



Transduction Efficiency (%)



VECTOR UPGRADE:

Metrics compared to academic process

FAB-201 and AVR-RD-04 drug product data

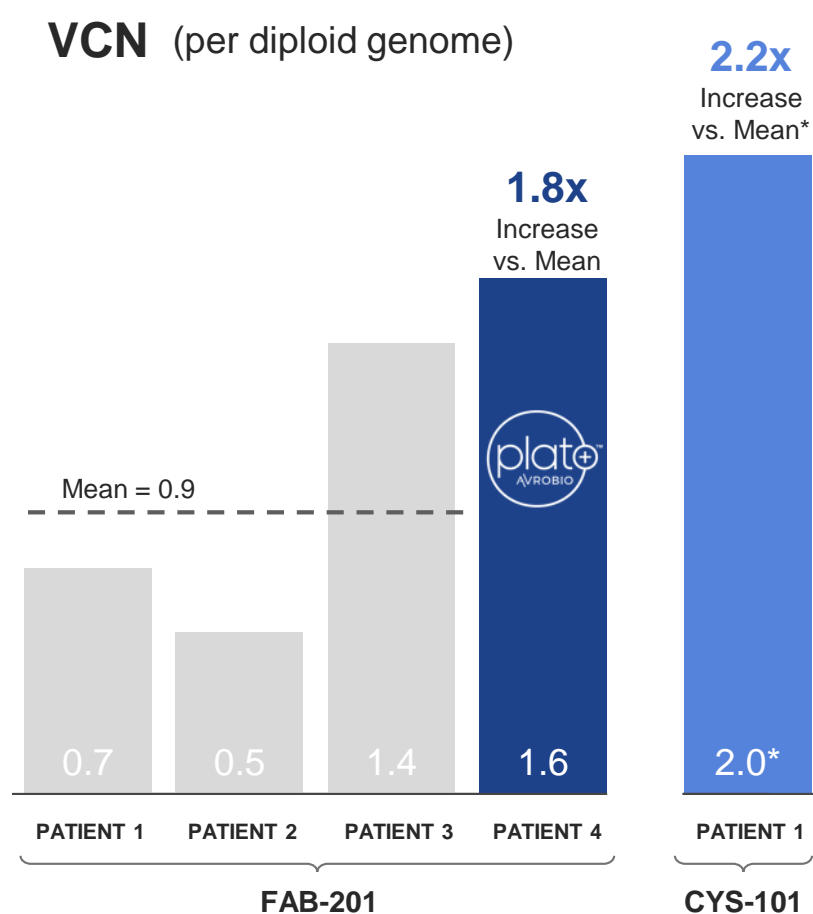
FAB-201 with plato™

- 4-plasmid vector (LV2)
- Bu TDM conditioning
- Automated manufacturing

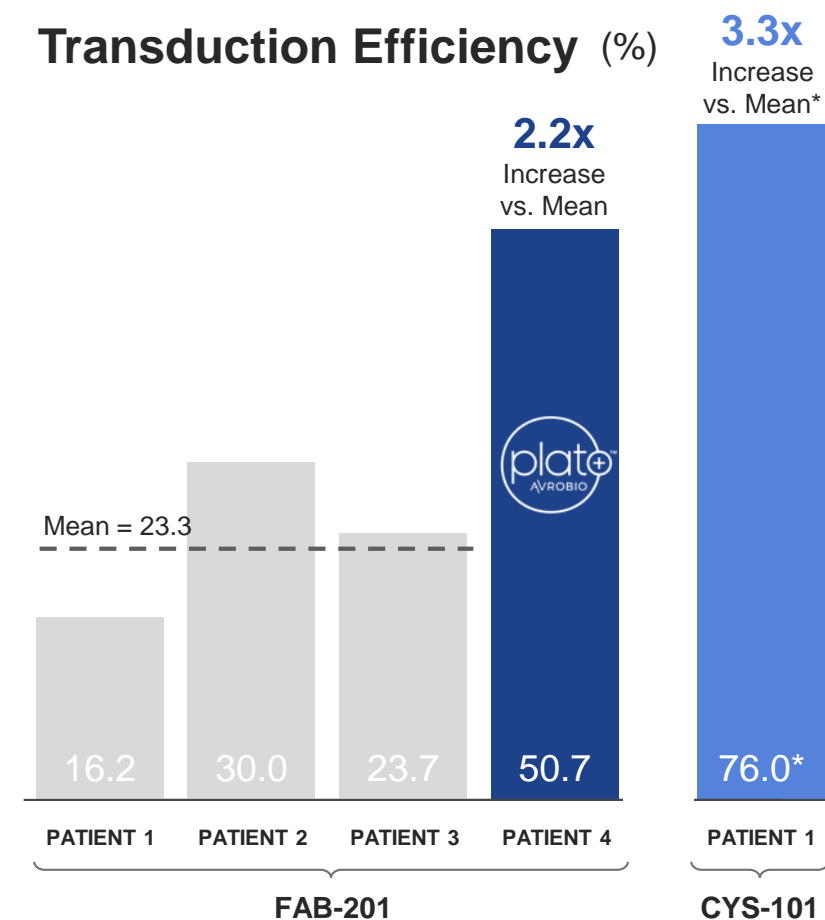
AVR-RD-04 with “plato-like”

- 4-plasmid vector
- Bu TDM conditioning
- Manual manufacturing

VCN (per diploid genome)



Transduction Efficiency (%)



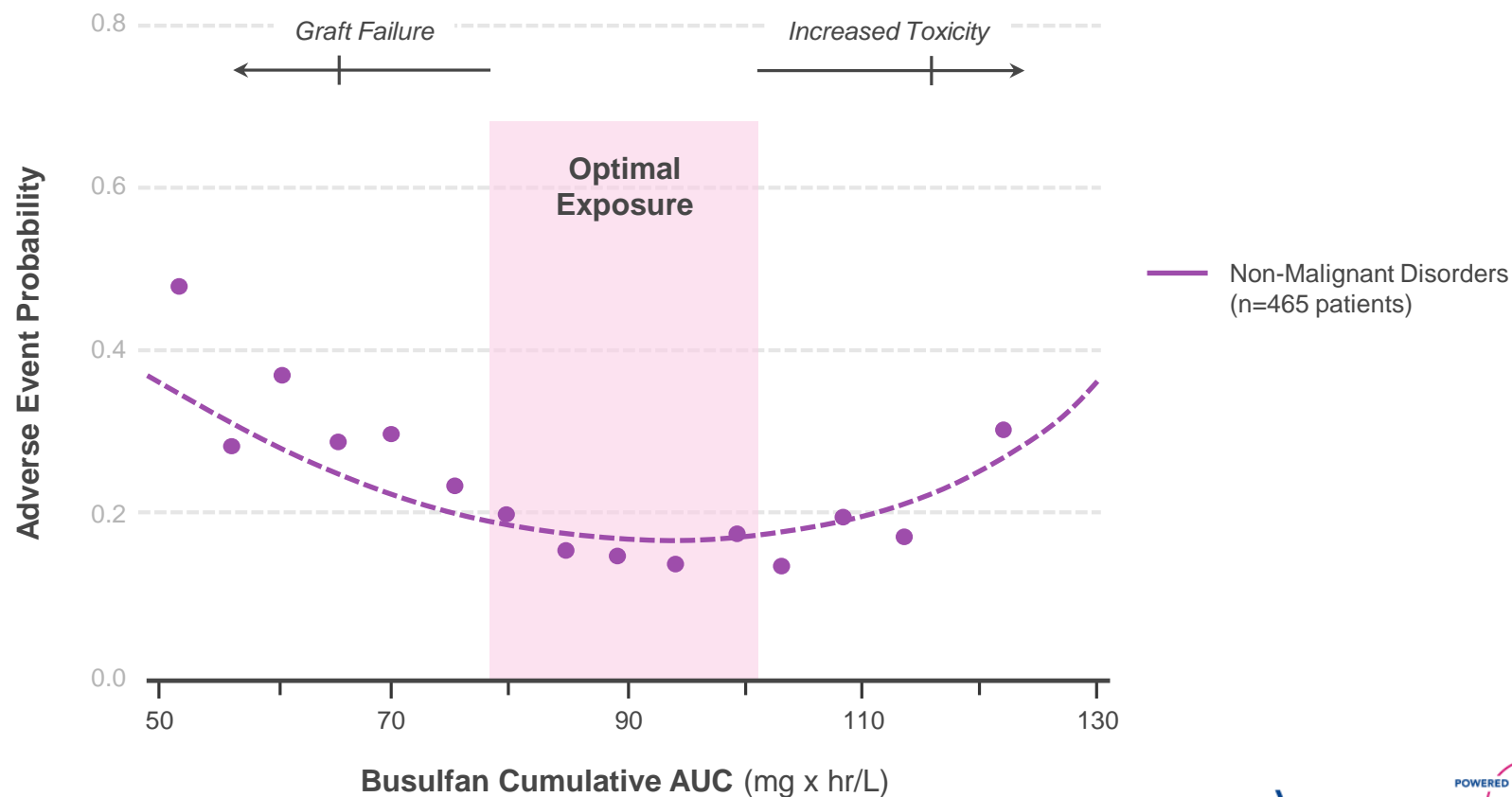
PRECISION CONDITIONING UPGRADE:

Targeted busulfan intended to balance optimal engraftment with enhanced safety

Meta-analysis of 465 patients identified optimal exposure

Optimized precision dosing designed to enhance tolerability

Lowest rate of adverse events in the Bu90 range



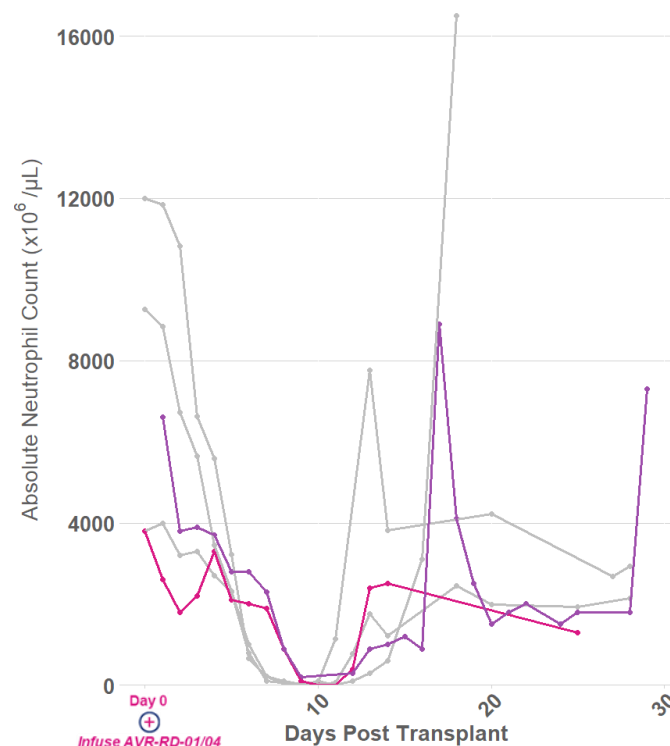
PRECISION CONDITIONING UPGRADE:

New
data
point

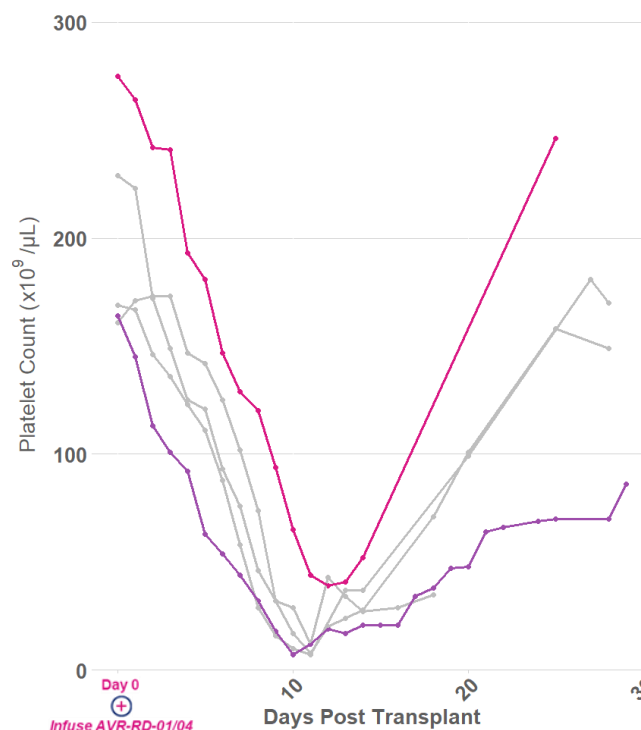


Rapid neutrophil and platelet recovery with minimal lymphocyte depletion using Busulfan TDM

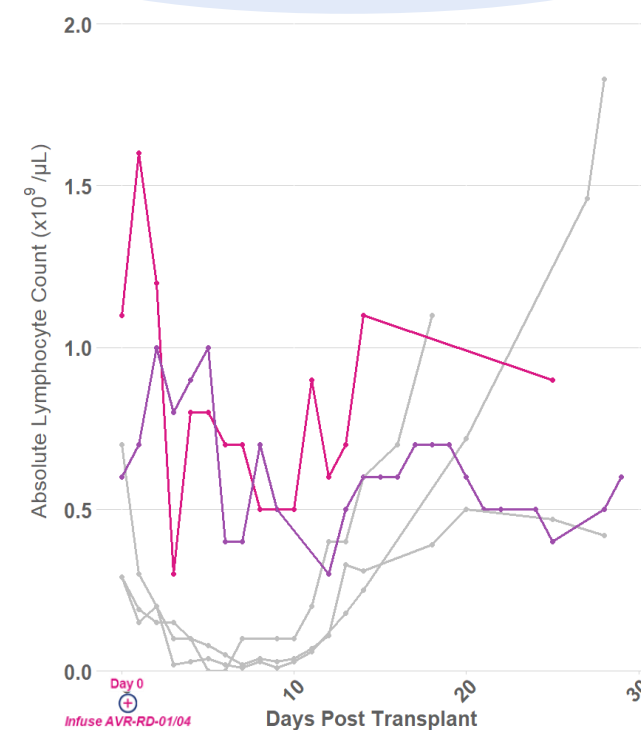
Absolute Neutrophil Count (ANC)



Platelet Count



Absolute Lymphocyte Count



— Cystinosis Patient 1: Busulfan — Fabry Patients 1 – 3: Mel — Fabry Patient 4: Bu90-TDM

Fabry: Patients #1-3 Melphalan 100mg/m²; Patient #4 Busulfan 'AUC 90'; Cystinosis: Patient #1 Busulfan 'AUC 90'

Threshold levels for prophylactic supportive care in HSC Tx; ANC <0.5 x 10⁹ per liter (AABB); Platelets <10 X 10⁹ cells/L (AABB)

NOTE: Neutrophil counts - G-CSF administration post gene therapy: Pt 1: 7 Doses, Day 7 – 14, Pt 2: 11 Doses, Day 7 – 17, Pt 3: 6 Doses, Day 7 – 12, Pt 4: 5 Doses, Day 8 – 12

NOTE: Platelet counts - Platelet Transfusion: Pt 1: Day 10; Pt 2, 3: Day 11, Pt 4: no transfusion

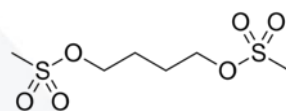
TDM = Therapeutic Drug Monitoring; G-CSF = Granulocyte-colony stimulating factor



PRECISION CONDITIONING UPGRADE: Designed to access “hard-to-reach” compartments

BRAIN

Busulfan crosses blood-brain barrier and eliminates resident microglia cells making space for gene-modified cells

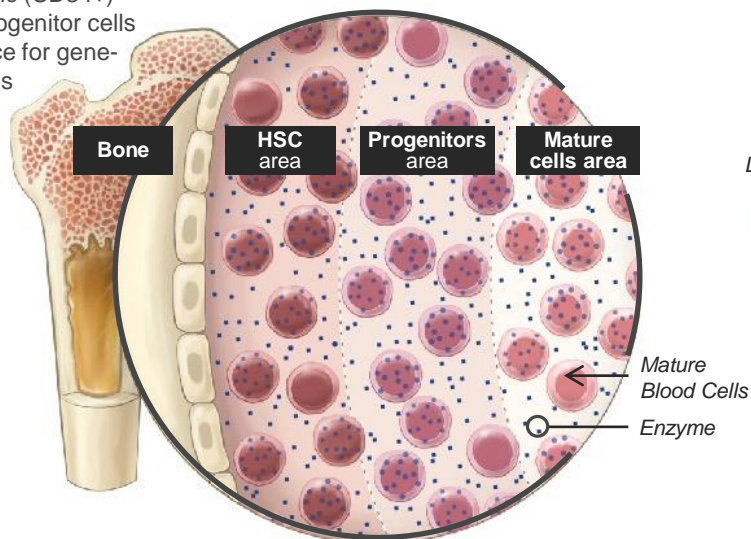


IN THE BONE MARROW

Busulfan eliminates hematopoietic (CD34+) stem and progenitor cells making space for gene-modified cells

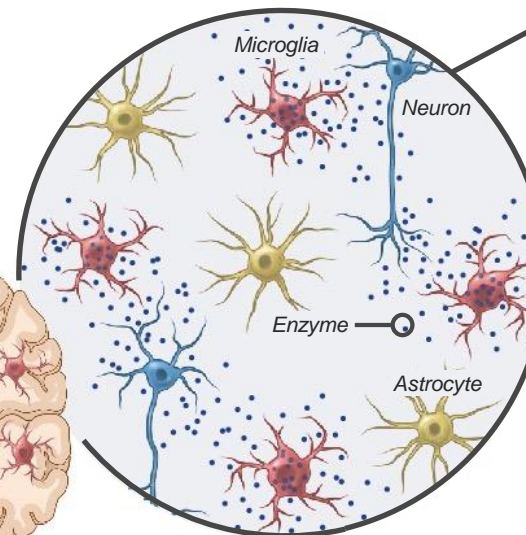
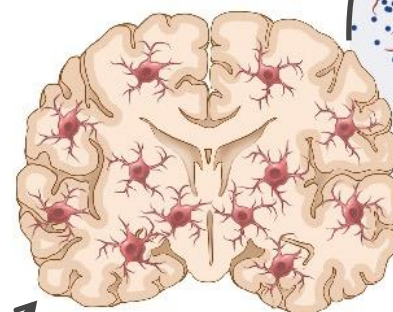
TRANSDUCED
CD34+ CELLS

BONE MARROW

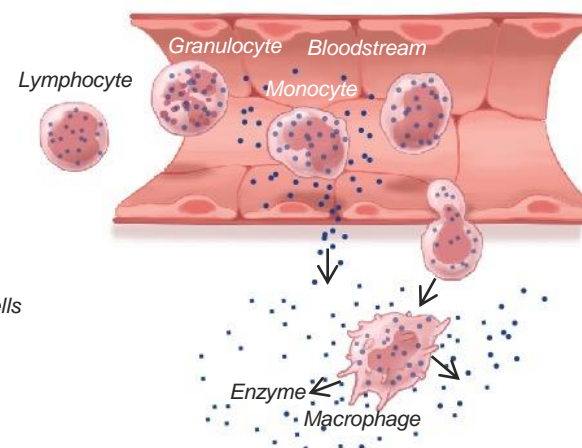


MICROGLIA

Potential for widespread microglia engraftment throughout the brain

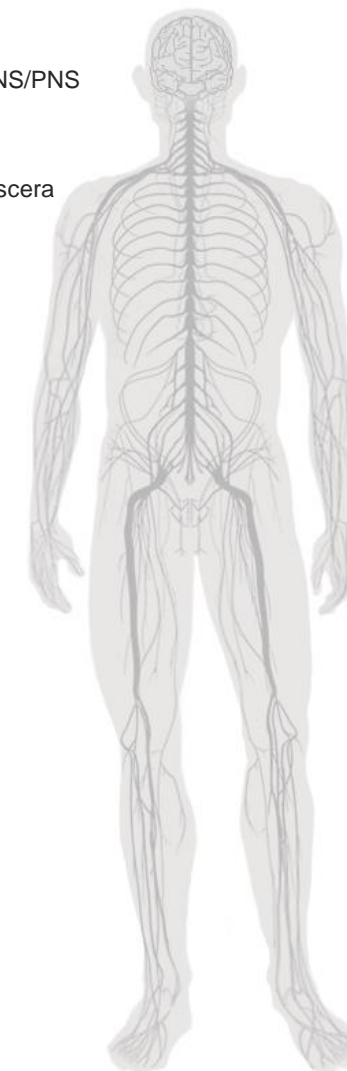


PERIPHERAL TISSUE



CNS/PNS

Viscera



AUTOMATION UPGRADE:

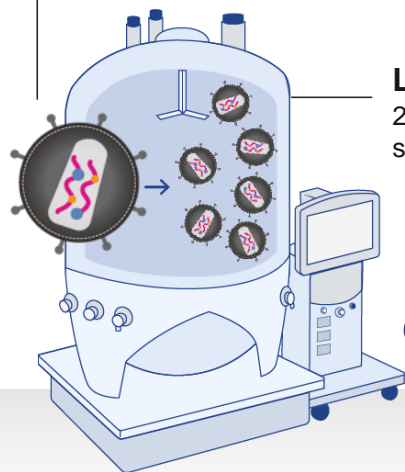
Designed to deliver large-scale manufacturing

Differentiated, cost-effective approach

1 Vector production

HIGH VOLUME / TITRE

Vector with disease-specific transgene



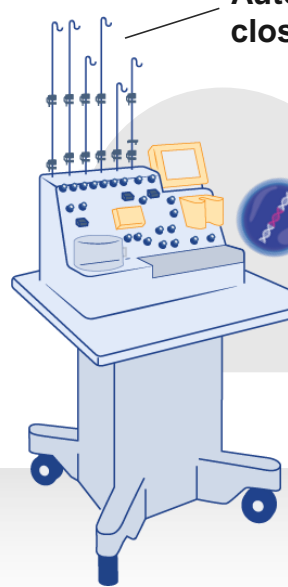
Large bioreactor
200 liter serum-free suspension culture

↓ **Frozen in aliquots**
to streamline supply chain

2 Drug product production

INCREASE CONSISTENCY

Automated, closed system

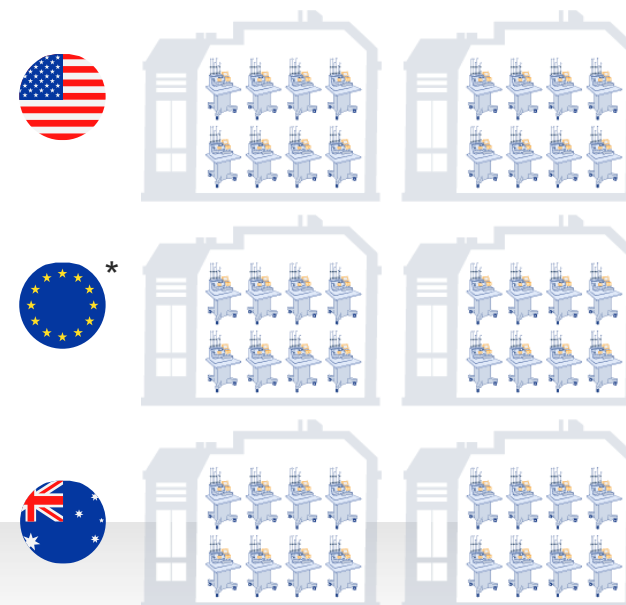


CD 34+ hematopoietic stem cells

↓ **Cryopreserved**
to enable convenient dosing

3 Scalable, global production suites

COST-EFFECTIVE SCALE-OUT



Illustrative



AUTOMATION UPGRADE:

Poised to manufacture at scale

Designed to optimize potency and safety, and overcome historic CMC bottlenecks

VECTOR



2,400 PATIENTS
ANNUALLY

~50 patients per run

~12 runs per year per suite
(200 L scale bioreactor runs (10^9 titre))

4 production suites



DRUG PRODUCT

2,400 PATIENTS
ANNUALLY



100 patients per unit per year

8 automated units per suite

3 global production suites



Illustrative

3 UPGRADES IN PLACE:

New
data
point

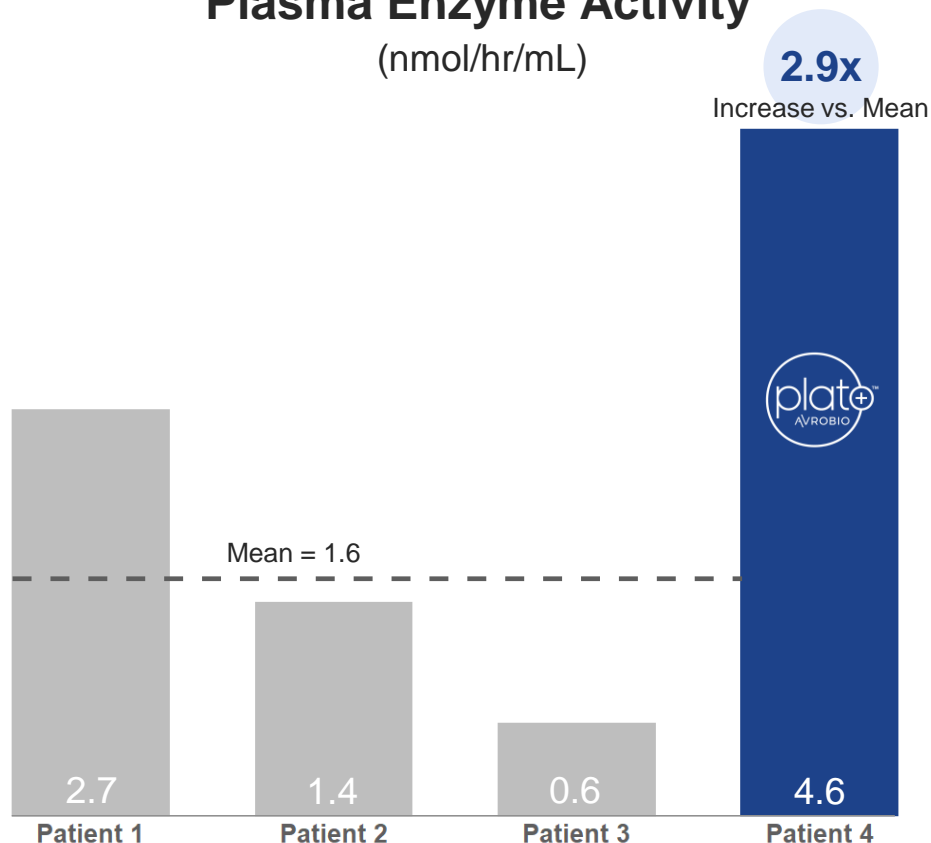


plato™ metric compared to academic process

FAB-201 THREE MONTH data for patient #4 with plato™ vs. patients #1-3

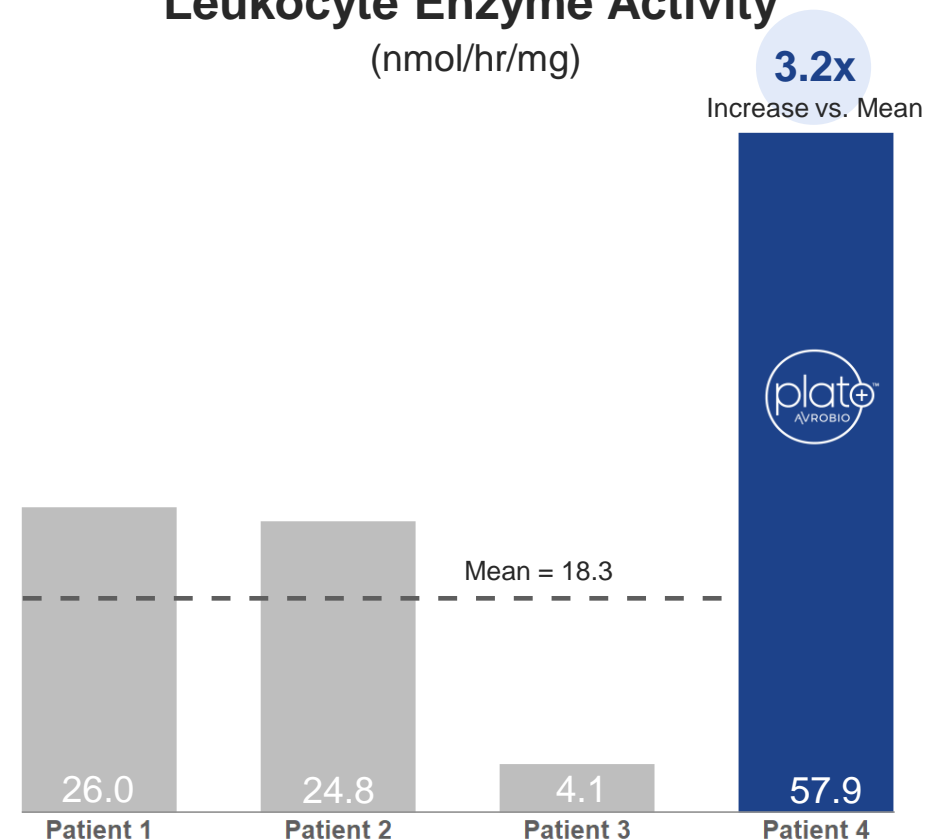
Plasma Enzyme Activity

(nmol/hr/mL)



Leukocyte Enzyme Activity

(nmol/hr/mg)



ASGCT 2020 data update – key takeaways



New data show consistent results across Fabry disease and cystinosis programs

Long-term Fabry patient data

Sustained long-term positive trends

- Patient 1 in the Phase 2 trial continues to show stable leukocyte and plasma AGA enzyme activity, now out 22 months
- Patient 3 in the Phase 2 trial shows increased leukocyte and plasma AGA enzyme activity, decreased plasma lyso-Gb3 level, and stable VCN at new time points
- All three Phase 1 patients off ERT remain off ERT

First Fabry plato™ patient

plato continues to perform

- One-month plasma lyso-Gb3 decrease of 43% vs. baseline
- Three-month leukocyte and plasma enzyme activity levels 3x greater than mean of other three patients at same timepoint in Phase 2 trial
- Rapid neutrophil and platelet recovery with minimal lymphocyte depletion post Bu90 conditioning

Cystinosis Patient 1 data

Positive trends at six months, including kidney function measures

- eGFR and serum creatinine measures trending positively at 6 months
- Pill burden remains significantly lower than at baseline

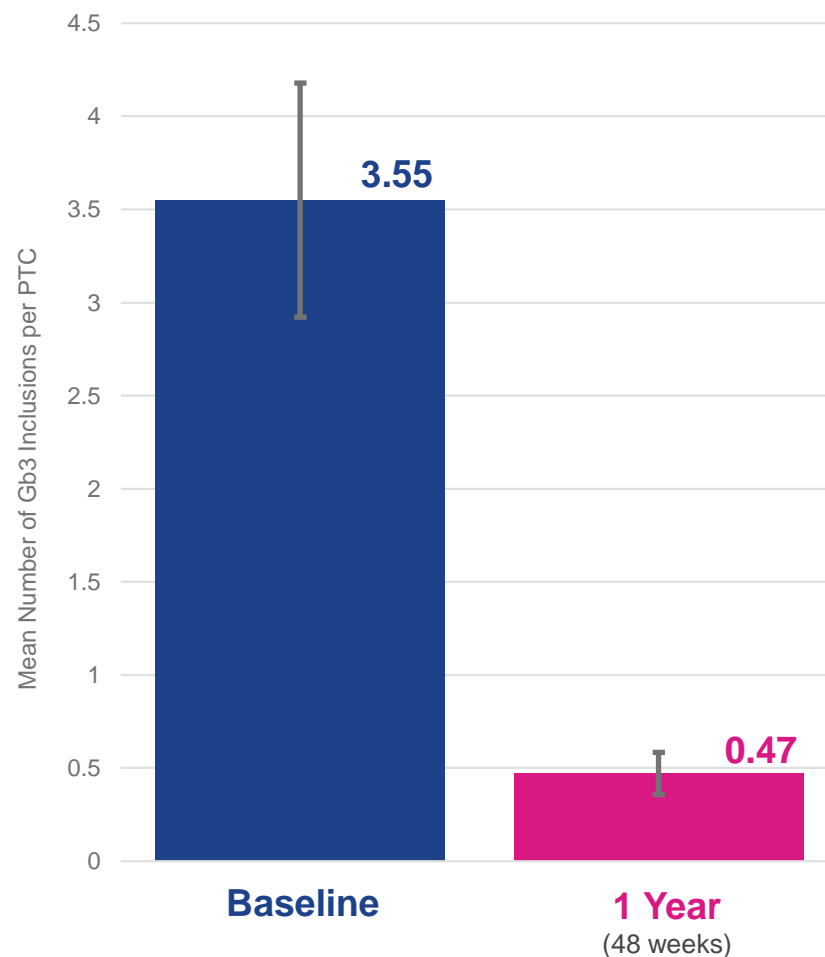


Appendix



Patient 1: 87% substrate reduction in kidney biopsy at 1 year

Average
number of **Gb3**
inclusions
per peritubular
capillary (PTC)



- Unpaired t-test for difference between $n=55$ PTCs at baseline vs. $n=101$ PTCs at 1 year; $p < 0.0001$
- Error bar represents the standard deviation

Baseline: The last available, non-missing observation prior to AVR-RD-01 infusion

Note: With respect to Fabry disease, Gb3 inclusions per PTC is interchangeable with GL-3 inclusions per KIC

FAB-201-1: First patient in FAB-201 clinical trial

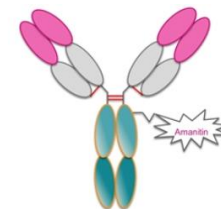
PTC: Peritubular Capillary; Gb3: Globotriaosylceramide; GL-3: Globotriaosylceramide; KIC: Kidney Interstitial Capillary

New collaborations advancing leadership in lentiviral gene therapy



Fully Automated Bu-TDM Immunoassay

- AVROBIO and Saladax announced agreement to develop and validate Saladax's fully automated nanoparticle immunoassay kit
- Designed to work on most automated hospital analyzers
- Regular technician, 24/7 analysis possible with results anticipated in minutes using only microLs of blood
- Designed to analyze 10-100s samples per machine/hour
- Expected to eliminate Bu degradation errors as assay conducted in real-time at the point of care
- Scalable



Antibody-Drug Conjugate

- AVROBIO and Magenta announced research & clinical collaboration agreement to evaluate Magenta's preclinical CD117-targeted antibody conjugate to amanitin (MGTA-117) in conjunction with AVROBIO investigational gene therapies
- Designed to deplete only hematopoietic stem and progenitor cells
- Has shown promising data in non-human primates
- MGTA-117 currently in IND-enabling studies
- Each party retains commercial rights to its own programs



Hematopoietic reconstitution occurs in two distinct phases

A few thousand long-term engrafting cells stably sustain levels of transgene product

First wave of short-term progenitor cells start to exhaust with progressive takeover by a smaller population of long-term engrafting cells

