

Power and Precision in Cancer Radiotherapeutics



Norman LaFrance, MD

Chief Medical Officer

nlafrance@plustherapeutics.com

**2022 SNMMI Therapeutics Conference** 

# **Forward-Looking Statements**

This presentation contains forward-looking statements within the meaning of the Private Securities Litigation Reform Act of 1995. Any statement in this document that is not a historical fact is a "forward-looking statements" within the meaning of Section 27A of the Securities Act and Section 21E of the Securities Exchange Act and are usually identified by the use of words such as "anticipates," "believes," "estimates," "expects," "intends," "may," "plans," "projects," "seeks," "should," "will," and variations of such words or similar expressions. We intend these forward-looking statements to be covered by the safe harbor provisions for forward-looking statements contained in Section 27A of the Securities Act and Section 21E of the Securities Exchange Act of 1934, as amended, and are making this statement for purposes of complying with those safe harbor provisions. These forward-looking statements reflect our current views about our plans, intentions, expectations, strategies and prospects, which are based on the information currently available to us and on assumptions we have made. Although we believe that our plans, intentions, expectations, strategies and prospects as reflected in or suggested by those forward-looking statements are reasonable, we can give no assurance that the plans, intentions, expectations or strategies will be attained or achieved. Furthermore, actual results may differ materially from those described in the forward-looking statements and will be affected by a variety of risks and factors that are beyond our control.

Risks and uncertainties for Plus include, but are not limited to: an inability or delay in obtaining required regulatory approvals for product candidates, which may result in unexpected cost expenditures; risks inherent in drug development in general; uncertainties in obtaining successful clinical results for product candidates and unexpected costs that may result therefrom; failure to realize any value of certain product candidates developed and being developed in light of inherent risks and difficulties involved in successfully bringing product candidates to market; inability to develop new product candidates and support existing products; the approval by the FDA and any other similar foreign regulatory authorities of other competing or superior products brought to market; risks resulting from unforeseen side effects; risk that the market for the combined company's products may not be as large as expected; inability to obtain, maintain and enforce patents and other intellectual property rights or the unexpected costs associated with such enforcement or litigation; inability to obtain and maintain commercial manufacturing arrangements with third-party manufacturers or establish commercial scale manufacturing capabilities; loss of or diminished demand from one or more key customers or distributors; unexpected cost increases and pricing pressures; economic recession and its negative impact on customers, vendors or suppliers; uncertainties of cash flows, expenses and inability to meet working capital needs; and other risks and uncertainties detailed in the risk factors section of Plus' Form 10-K and Forms 10-Q filed with the SEC, as well as other filings Plus makes with the SEC from time-to-time. Many of these factors that will determine actual results are beyond Plus' ability to control or predict. Plus disclaims any obligation to update information contained in these forward-looking statements, whether as a result of new information, future events or otherwise, except as required by law.



We believe in the critical importance in developing & delivering innovative, targeted radiotherapeutics for patients battling rare & difficult-to-treat cancers.



# Radiopharmaceuticals for Cancer

GUGGENHEIM

February 3, 2022

High Alpha & Low Beta: A Primer on Therapeutic Radiopharmaceuticals as a Compelling Next-Gen Approach for Solid Tumors

"Theoretically, any cancer can be cured if enough radiation can be delivered to it."

Dr. Andrew Brenner
Professor Neuro Oncology & Neurosurgery
Kolitz/Zachry Endowed Chair Neuro-Oncology Research

In 2016, there were ~3 million cancer survivors treated with radiation (29% of all cancer survivors) & this number is projected to see a large increase over the next several years.

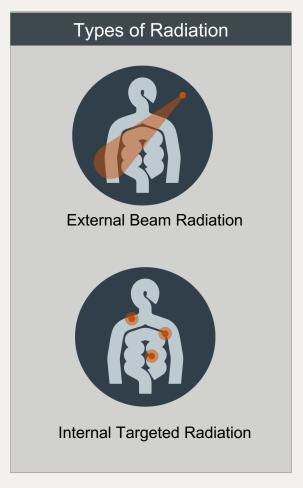
Cancer Epidemiol Biomarkers Prev 2017 Jun;26(6):963-970

# Radiotherapeutics WW Market Size Beta Brachytherapy Alpha \$5,000





# **Targeted Radiation Therapy & Mechanism of Action**



# Absorbed Radiation & DNA Damage

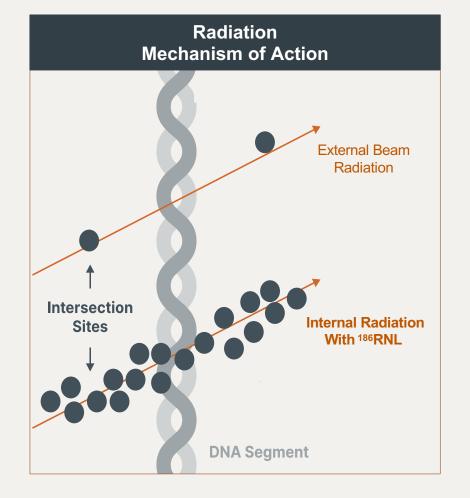
### **1 Gray Radiation**



### 10<sup>5</sup> Ionizations

1,000 damaged DNA bases 1,000 single strand (SS) breaks 20-40 double strand (DS) breaks

Absorbed Radiation & Recurrent GBM						
DS DNA Breaks						
EBRT (35 Gy) 700 - 1,400						
<sup>186</sup> RNL (600 Gy)	12,000 - 24,000					



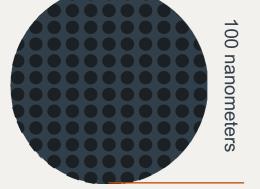


# Lead Investigational Drug: Rhenium-186 NanoLiposome (186RNL)

# Proprietary Nanoscale Compound with a Unique Isotope

# Rhenium-186

**BMEDA** 



Rhenium-186

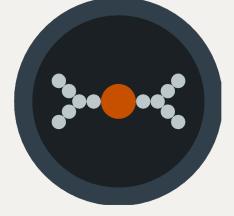


+ Dual energy emitter: beta (cytotoxic) & gamma (imaging)

+ High radiation density: overwhelms innate DNA repair mechanisms

+ Short average path length (1.8 mm): high precision

+ Low dose rate: safer for normal tissues



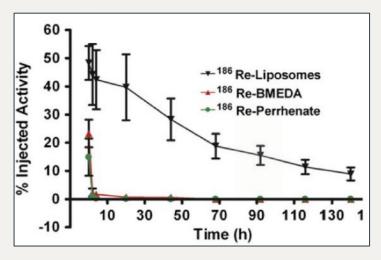
**NanoLiposome** 

Rhenium-186 NanoLiposome



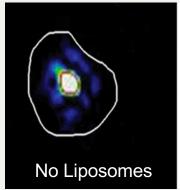
# Spatiotemporal Behavior of <sup>186</sup>RNL Following Direct Brain Delivery

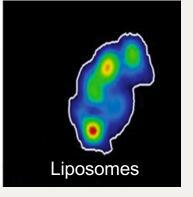
### **Prolonged Half-Life & Brain Retention**



### **Prolonged Tumor Retention**

Liposomal encapsulation significantly extends the in vivo intracranial half-life of Rhenium-186 (90 hours) & decreases clearance rate from the brain.





### **Reduced Tumor Dispersion**

Liposomal encapsulation significantly extends Rhenium-186 retention within the tumor & therefore improves dispersion characteristics in tissues.



# Rare & Difficult-to-Treat Cancers

# Responsible for Substantial Morbidity & Mortality Worldwide

- + Rare cancers represent 27% of all cancers; all pediatric cancers are rare
- + Rare cancers account for 25% of all cancer deaths; 5-year survival rate is lower for patients with a rare cancer than those with a more common cancer
- + Treatments for rare cancers are eligible for orphan drug designations

### **FACTS ABOUT CNS TUMORS**



Glioblastoma: deadliest, most common brain cancer in adults

**Leptomeningeal Metastases:** late complication in 5% of cancer patients

**Pediatric Brain Cancer:** 2<sup>nd</sup> most common type of cancer in children

### **FACTS ABOUT LIVER TUMORS**



**Primary Liver Cancer:** 42k cases diagnosed annually in U.S. with 5-year survival of 20%

**Secondary Liver Cancer:** ~50-60% of colorectal cancer patients develop metastases to liver



# **Plus Therapeutics Pipeline**

Investigational Drug	Indication	FDA Designation(s)	External Funding	Stage	Status
	Recurrent Glioblastoma	Orphan Drug Fast Track	NIH/NCI to Phase 2	Phase 1 Dose Escalation	Enrolling
	Recurrent Glioblastoma (22.3 mCi)	Orphan Drug Fast Track	NIH/NCI to Phase 2	Phase 2	2022
<sup>186</sup> RNL	Recurrent Glioblastoma - retreatment	_	_	_	Submitted 2021 FDA
	Leptomeningeal Metastases	Fast Track	_	Phase 1	Enrolling
Pediatric Brain Cancer		_	_	Pre-IND	IND Submission 2022
188DNII DAM	Hepatocellular Carcinoma	Pre-clinical			IND Enabling CMC & Pre-clinical
<sup>188</sup> RNL-BAM	Liver Metastases	Pre-clinical			IND Enabling CMC & Pre-clinical





Innovative, targeted radiotherapeutics for patients with central nervous system tumors.



# Glioblastoma (GBM)

A Rare, Incurable, & Fatal Brain Cancer with No Good Treatment Options





### <sup>186</sup>RNL Preclinical GBM Data

### **Tumor Regression in U87 & U251 Intracranial Xenograft Models**

Tumor

growth &

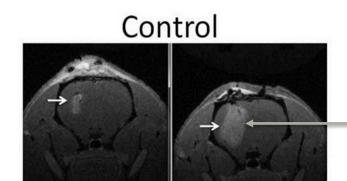
untreated

control

expansion in

animals with

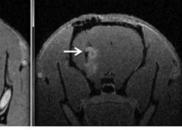
brain cancer.

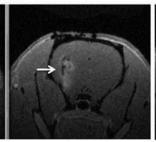


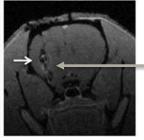
Day -1 Day 14 Control

# <sup>186</sup>Re-Liposome Treatment









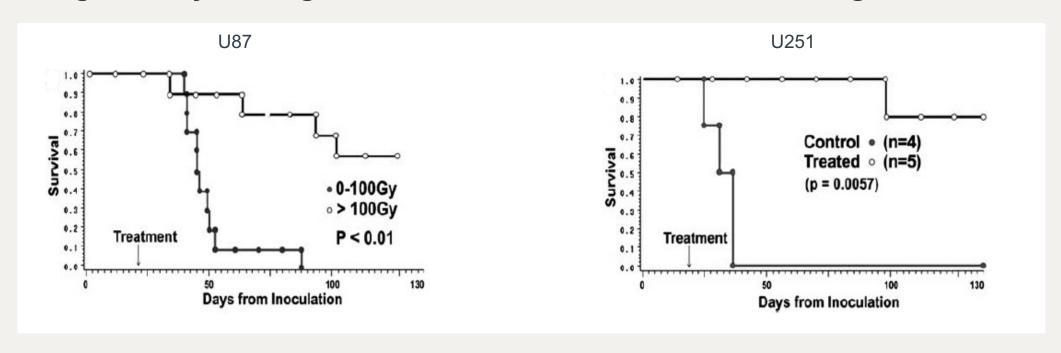
Tumor regression in <sup>186</sup>RNL treated brain cancers.

- Day -1
- Day 14 Post-Tx
- Day 28 Post-Tx Day 70 Post-Tx
- + Bioluminescence assay showed many of the treated animals had a loss of activity to background levels suggesting complete eradication of the tumor.
- + MRI analysis (above) supported the observation of tumor eradication.
- + Blinded histologic evaluation by neuropathologist showed no residual disease.



### <sup>186</sup>RNL Preclinical GBM Data

### <sup>186</sup>RNL Significantly Prolongs Survival in U87 & U251 Intracranial Xenograft Models



- Doses of up to 1,845 Gy were tolerated without weight loss or neurological deficit.
- No maximum tolerated dose of <sup>186</sup>RNL reached.
- Statistically significant prolongation in survival, limited only be the end of the experiment.
- Blinded histologic analysis by neuropathologist showed no residual tumor all treated animals.





# **ReSPECT-GBM Phase 1/2 Clinical Trial Design**

Multi-center, sequential cohort, open-label, volume & dose finding study of the safety, tolerability, & distribution of <sup>186</sup>RNL given by convection enhanced delivery to patients with recurrent or progressive malignant glioma after standard surgical, radiation, and/or chemotherapy treatment.

- + Single arm, prospective Phase 1/2 study utilizing a modified Fibonacci dose escalation scheme, followed by an expansion at the designated recommended phase 2 dose (RP2D).
- + Maximum number of planned subjects: up to 55 subjects (including patients enrolled in the Phase 1 dose escalation trial & a subsequent cohort at the RP2D).
- + Supported by a NIH/NCI grant through Phase 2.











# <sup>186</sup>RNL for Recurrent Glioblastoma

**Potential Advantages Compared to External Beam Radiation Therapy** 







# **Trial Enrollment & Patient Demographics**

### Patient Demographics (N=22)

Gender			
Male	14 (64%)		
Female	8 (36%)		
Tumor Volume	Average = 8.3 cc; Range = 0.9 cc - 22.8 cc		
Prior Treatments	Average = 1.7 treatments; Range = 1 – 3 treatments		
Prior Bevacizumab	N = 5 patients		
IDH Mutational Status			
Wild type	18 (90%)		
Mutated	2 (10%)		
MGMT Status			
Methylated	4 (25%)		
Unmethylated	12 (75%)		
Glioma grade			
Grade IV	20 (91%)		
Grade III	2 (9%)		

### **Updated Trial Enrollment**

Cohort	Infused Volume (mL)	Total <sup>186</sup> RNL Activity (mCi)	Concentration (mCi/mL)	Average Absorbed Dose (Gy)	Status
1	0.66	1.0	1.5	198	
2	1.32	2.0	1.5	122	
3	2.64	4.0	1.5	234	
4	5.28	8.0	1.5	171	Enrolling Cohort 8
5	5.28	13.4	2.5	423	(n = 23 subjects)
6	8.80	22.3	2.5	287	, ,
7*	8.80	22.3	2.5	584	
8	12.3	31.2	2.5	TBD	

Cohort 7 utilized same volume & dose as cohort 6 but with increase in maximum flow rate to 20 microliters/minute





# Case Study: Tumor Coverage & Retention

### Cohort 5/Subject 01-014: MRI & SPECT/Radiation Dosimetry

Baseline MRI Scan

SPECT Scan At 24 Hours

SPECT Scan At Day 5

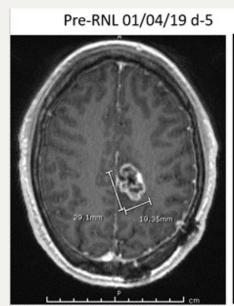
- + Deep brain tumor recurrence
- + Tumor Volume: 6.5 mL
- + Tumor Coverage: >90%
- + Absorbed Dose Delivered to Tumor: 419 Gy

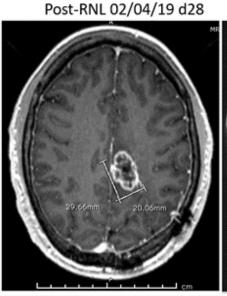


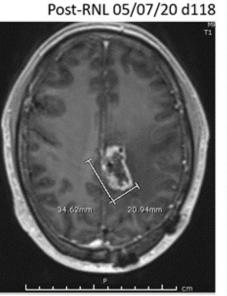


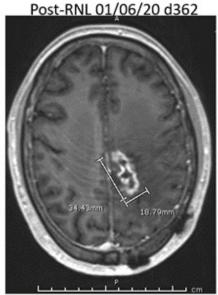
# Natural History of Recurrent GBM Lesions After <sup>186</sup>RNL

Cohort 5/Subject 01-014: Tumor Response Observed to Day 362









- MRI scans revealed an initial increase in size which peaked at Day 118, with some associated edema, pseudo-progression
- + Tumor shrinkage out to at least Day 362
- + Remains alive at 160 weeks after single treatment





# **Patient Safety**

### <sup>186</sup>RNL Appears to be Safe & Well Tolerated

Thus far, in the Phase 1 study of 23 subjects in 8 dosing cohorts with recurrent glioblastoma receiving a single dose of <sup>186</sup>RNL:

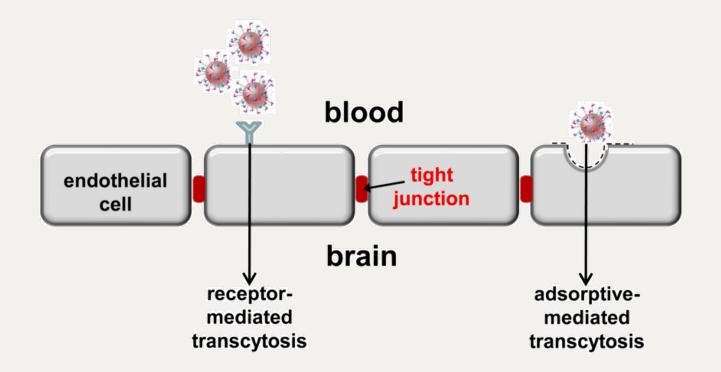
- + There have been no dose limiting toxicities.
- + The majority of AEs reported were mild or moderate (Grade 1 or 2) in intensity.
- + Most AEs were considered causally unrelated to <sup>186</sup>RNL except scalp discomfort, which was considered related to the surgical procedure.
- + Serious adverse events:

Serious Adverse Event	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Total
Osteonecrosis (Left Shoulder)	0	0	1	0	0	1
Seizure	0	1	2	0	0	3
Vasogenic cerebral edema	0	0	2	0	0	2
Pneumonia	0	0	1	0	0	1



# **Drug Delivery to the Central Nervous System**

BBB Significantly Hinders Passage of Systemically Delivered Therapeutics & the Brain Extracellular Matrix Limits the Longevity of Locally Delivered Agents





Proposed & Introduced by NIH Researchers in 1990s to Deliver Drugs That Do Not Cross the BBB & Are Too Large to Diffuse Effectively Over the Required Distances

### **Complicated Modeling**

Optimize simulations for flow trajectory & infusion parameters

### **Simplified Modeling**

Define clinical use (protocol development)

### Darcy's Law

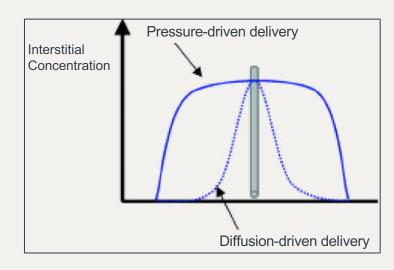
$$q = -\frac{\kappa}{\mu} \nabla \rho$$
 where

q = instantaneous flow rate

 $\kappa$  = permeability

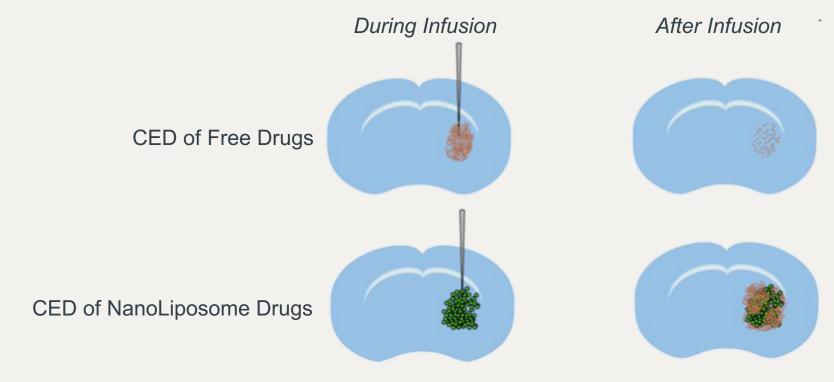
 $\mu$  = dynamic viscosity of the fluid

 $\nabla \rho$  = pressure drop





Locally Delivered NanoLiposomes Bypass the BBB Altogether, are Widely-Distributed, & Provide Long-Lasting Drug Release







# Technique Generates a Pressure Gradient To Deliver <sup>186</sup>RNL Through the Interstitial Spaces of the Central Nervous System

### Workflow

- 1) Treatment planning
- 2) Imaged guided catheter placement
- 3) Catheter placement confirmation
- 4) Bedside infusion
- 5) Monitoring

### **Potential Benefits**

- + Large target coverage volumes
- + High local concentration at target volume
- + Low systemic exposure, less side effects
- + Minimized systemic drug-drug interaction
- + Homogeneous concentration profiles

### Delivery via CED Catheter







### Feasibility Demonstrated in All Cohorts, With Up to 4 Catheters Placed Per Patient

Evolution of Key Delivery Parameters

Absorbed Radiation Dose Correlates with OS

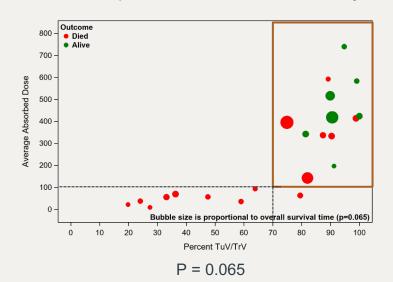
Delivery Reliability in Later Cohorts





Activity	1.0- 31.2 mCi
Volume	0.6 – 12.3 mL
Max Flow Rate	5 – 20 ul/min
CED Catheters	1 – 4 catheters/patient

### Therapeutic Threshold >100 Gy



### Cohort 1-4

- + 12 patients treated
- + 5/12 (42%) >100Gy

### Cohort 5-7

- + 11 patients treated
- + 9/11 (82%) >100Gy





# **ReSPECT-GBM Updated Efficacy Data Since SNO 2021**

**Current Enrollment is 23 in 7 Dosing Cohorts (March 2022)** 

# Overall Survival Data, N=23 (Stratification by Radiation Dose & Cohort)

Dose			Median OS	Mean OS				
(Gy)	Cohort	N	(wks)	(wks)	Alive	FPI	LPI	Duration
>100	1 to 5	8	82	88	2	3/10/15	7/22/20	280
>100	6 to 7	6	44	40	5	10/22/20	1/12/22	64
	Subtotal	14	46	67	7			
<100	1 to 5	7	22	23	0	3/10/15	7/22/20	280
<100	6 to 7	2	23	23	0	10/22/20	1/12/22	64
	Subtotal	9	22	23	0			

*Mono	Tx Bevacizumab	32.1
1110110	I A BOVACIEATIAN	OZ. 1

Study/Authors	Design	Year Published	N	Median Age (years)	> First Recurrence (%)	Performance Status	Median Survival (weeks)
BELOB Trial Taal et al. "	Phase II RCT	2014	50	58	0	ECOG (patients) 0 (13); 1(32); 2(5)	34.8
BRAIN Trial Friedman et al. <sup>3</sup>	Phase II RCT	2009	85	54	19	KPS (patients) 90-100 (38); 10-80 (47)	40.5
Kreisl et al. "	Phase II RCT	2009	48	53	N/A	KPS median (range) 90 (60-100)	31.0
Chambertain et al. 2	Retrospective	2010	50	64	68	KPS median (range) 80 (60-100)	37.0
Field et al. <sup>21</sup>	Phase II RCT	2015	62	55	31	KPS (patients) 90-100 (22); 70-80 (28), <70 (10); NA (2)	32.6
Nagane et al. <sup>33</sup>	Phase II single-arm	2012	29	57	42	KPS (patients) 90-100 (17); 70-80 (12)	45.7
Chen et al. 23	Retrospective	2015	57	61	0	KPS (patients) 90-100 (13); 70-80 (10); <70 (20); NA (14)	29.4
Duerinck et al. 17	Prospective cohort	2015	313	55	88	ECOG (patients) 0 (30); 1 (204); 2 (57); 3 (12); NA (10)	26.0
Pooled Historical Cohort			694				32.1
VB-111 TThP cohert	Phase II single- arm	NA	24	60	50	KPS median (range) 80 (60-100)	59.1

### **Key Points**

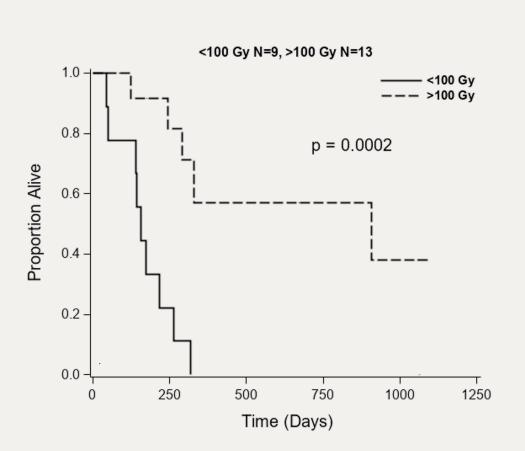
- + Cohorts 1-5 represent patients treated from 2015 to 2020
  - + 2 pts. still alive
  - + The median & mean survival is between 2-3 times monotherapy with Bevacizumab
- + Cohorts 6-7 have been treated recently, since October 2020
  - + Low overall survival related to recent enrollment
  - + 5/6 still alive
- + Empirically, patients with rGBM receiving >100 Gy survive longer than those receiving <100 Gy & longer than those receiving monotherapy bevacizumab

<sup>\*</sup> Cloughesy, T. et al. *Neuro-Oncology*, 22(5), 705–717, 2020 Brenner, A. et al. *Neuro-Oncology*, 22(5), 694–704, 2020 Wenger, K. et al. *Oncol Lett.* 14(1), 1141-1146, 2017



### **ReSPECT-GBM Clinical Trial**

### Comparative OS Based on Average Absorbed Radiation Dose



### **Summary**

- + No DLTs, favorable safety & tolerability profile
- + Delivery >100 Gy radiation correlates with increased OS
- + Recent cohorts (5-7) >80% delivery success
- + Radiation distribution volume in cohort 6/7 treats >50% market of rGBM
- + At cohort 6/7 level

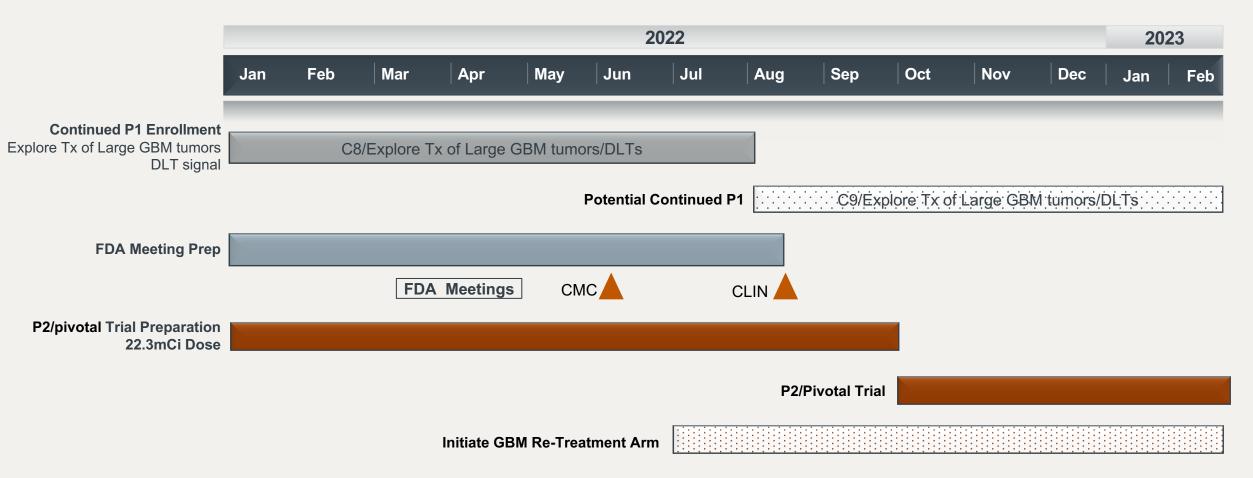
Cohort	Infused Volume (mL)	Total <sup>186</sup> RNL Activity (mCi)	Concentration (mCi/mL)	Average Absorbed Dose (Gy)
6*	8.80	22.3	2.5	584

+ Plan: Take cohort 6/7 22.3mCi dose to Phase 2/pivotal





### 2022 ReSPECT-GBM Clinical Timeline







# <sup>186</sup>RNL in Leptomeningeal Metastases

### **Disease Background**

+ Leptomeningeal metastases, also known as carcinomatosis, is a cancer that starts in one part of the body spreads to the leptomeningeal lining of the brain & spinal cord surrounding the cerebrospinal fluid (CSF) space.

### 100 nm NanoLiposomes in CSF

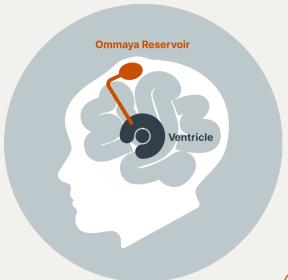
- + Circulate feely throughout the CSF
- + Migrate to meningeal surfaces where LMC is located
- + Have an extended half life several weeks vs. hours with unencapsulated drugs
- + Safe & effective in preclinical models

### **Phase 1 Clinical Trial**

- + 2-part dose escalation trial
- + 1st site at UTSW enrolling
- + Planned 5 sites
- + 5 cc delivered via Omaya reservoir
- + Feasibility & safety



### Delivery via Standard Ommaya Reservoir





# **ReSPECT-LM Trial Protocol Synopsis**

### **Leptomeningeal Metastases**

A Two-Part, Multicenter Phase 1 Study to Determine the Maximum Tolerated Dose/ Maximum Feasible Dose, Safety, & Efficacy of Single Dose Rhenium-186 Nanoliposome (186RNL) Administered via the Intraventricular Route for Leptomeningeal Metastasis

### + Primary Objectives

+ To characterize the safety & tolerability of a single dose of <sup>186</sup>RNL by the intraventricular route & to identify a maximum tolerated dose (MTD) and/or maximum feasible dose (MFD).

### + Secondary Objectives

- + Characterize the pharmacokinetic & dosimetry profile of a single dose of <sup>186</sup>RNL when administered intraventricularly via Ommaya reservoir.
- + Develop a multiple dosing strategy of <sup>186</sup>RNL for subsequent clinical trials.
- + Determine the overall response rate (ORR) defined as the proportion of all evaluable patients achieving a response as the best overall response at the time of progression.
- + Determine the duration or response (DoR) defined as the time from first response to LM progression.
- + Determine progression free survival (PFS) defined as the time from first treatment to date of LM progression or death from any cause.
- + Determine the overall survival (OS) define as the time from first treatment to date of death.

### + Endpoints

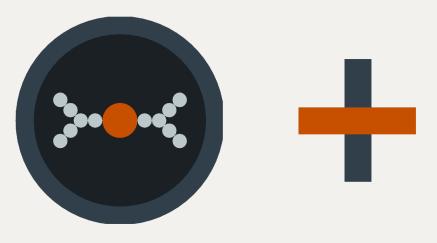
- + Primary Endpoints
  - + Incidence & severity of adverse events (AE) & serious adverse events (SAE)
  - + Incidence of dose limiting toxicities (DLT)





# Second Investigational Drug: Rhenium-188 NanoLiposome Biodegradable Alginate Microsphere (188RNL-BAM)

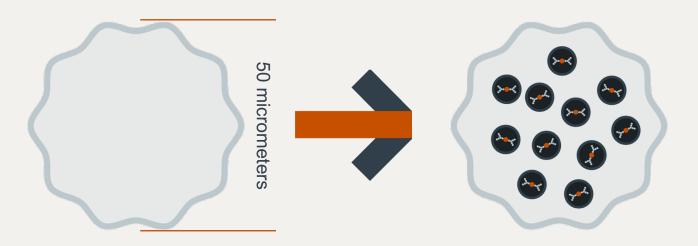
# Proprietary Microscale Compound with a Unique Isotope





### Rhenium-188

- + Dual energy emitter: beta (cytotoxic) & gamma (imaging)
- + Short average path length (3.1 mm): offers greater precision
- + Low dose rate: safer for normal tissues
- High radiation density: overwhelms innate DNA repair mechanisms
- Generator-produced for quick availability



**Biodegradable Alginate Microsphere** 

Rhenium-188 NanoLiposome Biodegradable Alginate Microsphere

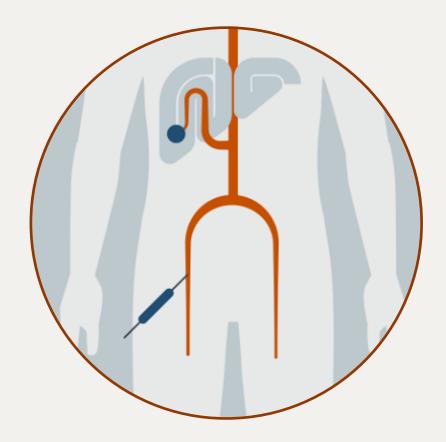


# <sup>188</sup>RNL-BAM Radioembolization Therapy

### In Development as a Non-Surgical Locoregional Treatment Option for Solid Organ Tumors

### The **Approach**

A single intra-arterial injection of <sup>188</sup>RNL-BAM in which biodegradable microspheres block the blood flow to the targeted solid organ tumors & simultaneously deliver a therapeutic payload of radiation.



# The Potential Advantages

Compared to 2 radioembolization therapies currently available, <sup>188</sup>RNL-BAM may offer:

- 1) Biodegradable microspheres
- 2) Higher quality imaging
- 3) Work-up predictive of final clinical outcome
- 4) Shorter production time via generator
- 5) Improved patient access, incl. ex-U.S.
- 6) Higher margins
- 7) Better translate to other indications



# <sup>188</sup>RNL-BAM Radioembolization Therapy: Initial Targets

### Liver Cancer is the 6th Most Common & 3rd Deadliest Cancer

### The **Challenges**

### **Hepatocellular Carcinoma**

The most common type of primary liver cancer.

+ Incidence: 42k

+ 5-Year Survival: 20%

### **Metastatic Colorectal Cancer**

A secondary form of liver cancer with a high level of severity.

+ Incidence: 150K

+ 5-Year Survival: 14%



## The **Opportunities**

Pursue new & relevant routes of administration & mechanisms of delivery/action.

Extend the life of patients with liver cancer through a safer, more targeted, & convenient treatment approach.



# 2022 Corporate Milestones

### Recurrent Glioblastoma (GBM)

- ♣ ReSPECT-GBM Phase 2/pivotal clinical trial
  - ♣ FDA CMC & Clinical Meetings
  - Complete CMC activities for 186RNL for GMP/Phase 3 drug supply
  - Initiate ReSPECT-GBM P2/pivotal trial
- → ReSPECT-GBM Phase 1 clinical trial of <sup>186</sup>RNL, dose escalation & report data
- Initiate & open ReSPECT-GBM retreatment protocol

### Leptomeningeal Metastases (LM)

Complete initial cohort enrollment, feasibility assessment in ReSPECT-LM Phase 1 clinical trial

### Pediatric Brain Cancer (PBC)

Obtain FDA IND approval & initiate ReSPECT-PBC Phase 1 clinical trial of 186RNL

### Liver Cancer

♣ Complete technology transfer & key CMC, FDA IND-enabling studies for <sup>188</sup>RNL-BAM asset







- + Headquarters: Austin, Texas
- + Manufacturing: San Antonio, Texas
- + Nasdaq: PSTV
- + Corporate Website: PlusTherapeutics.com
- + ReSPECT™ Website: ReSPECT-Trials.com

