

CARDIOMIOPATIE RARE, CARDIOPATIE NEUROMUSCOLARI E MALATTIA DI ANDERSON-FABRY

La terapia nella malattia di AndersonFabry: dagli studi, ai registri, alla real-life

Sandro Feriozzi
Nefrologia
Università Campus Bio-

Medico

Roma

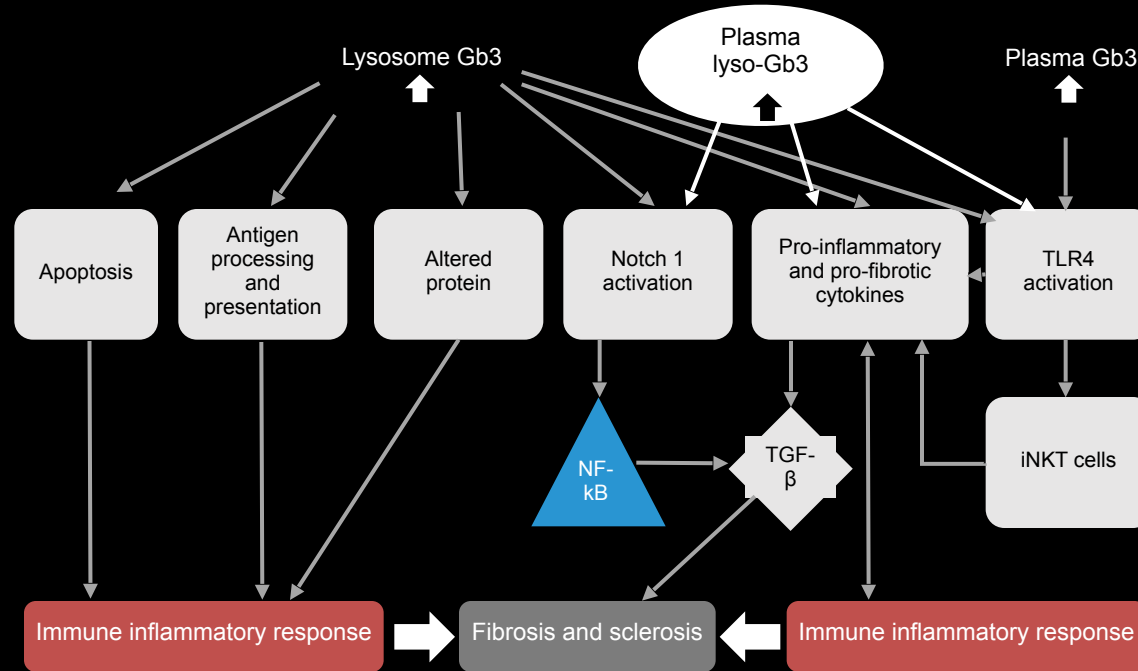


DISCLOSURES

S. Feriozzi has received travel assistance and honoraria for lecturing and for participating in advisory boards from Sanofi/Takeda/Amicus/Medtronic/ Chiesi



PATHOGENETIC HYPOTHESIS OF TISSUE DAMAGE IN FABRY DISEASE



Adapted from Rozenfeld P, Feriozzi S.
2017

Gb3, globotriaosylceramide; iNKT, invariant natural killer T cell; lyso-Gb3, globotriaosylsphingosine; NF-kB, nuclear factor kappa B; TGF-β, transforming growth factor-beta; TLR4, toll-like receptor 4.
Rozenfeld P, Feriozzi S. *Mol Genet Metab*. 2017;122(3):19–27.

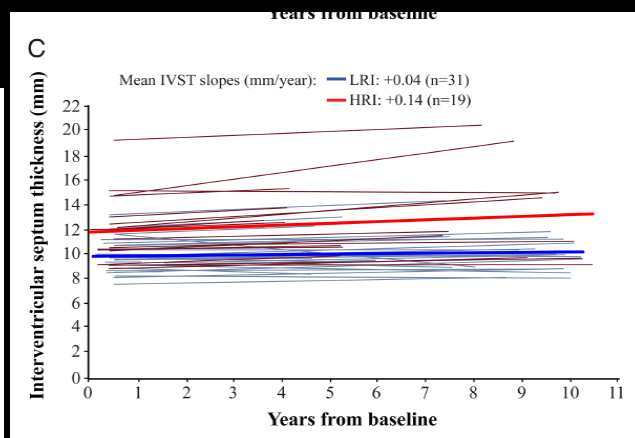
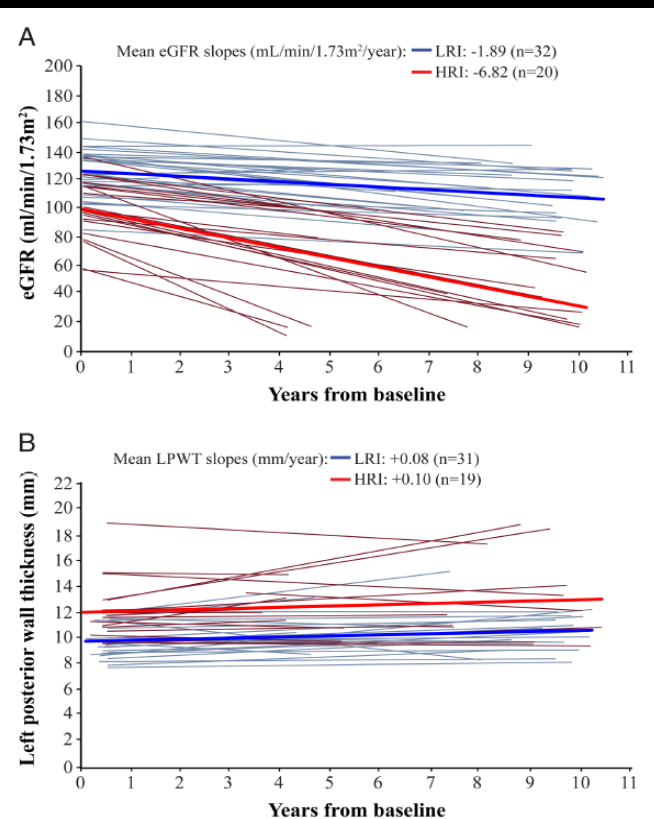
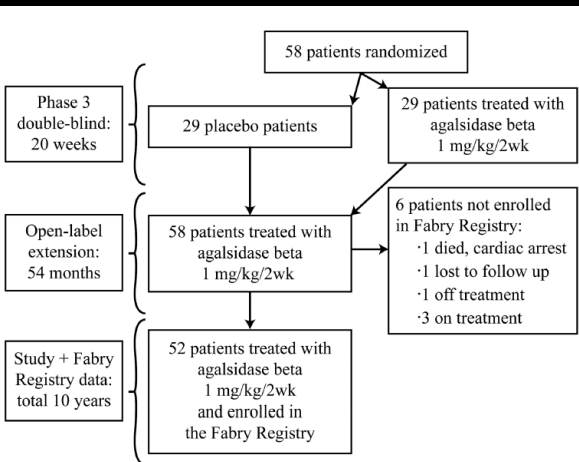
Rozenfeld & Feriozzi Mol Genet Metab 2017



OPEN ACCESS

Ten-year outcome of enzy with agalsidase beta in patients with Fabry disease

Dominique P Germain,¹ Joel Charrow,² Robert J Desnick,³ Nathalie Guffon,⁴ Judy Kempf,⁵ Robin H Lachmann,⁶ Roberta Lemay,⁷ Gabor E Linthorst,⁷ Seymour Packman,⁸ C Ronald Scott,⁹ Stephen Waldek,¹⁰ David G Warnock,¹¹ Neal J Weinreb,¹² William R Wilcox¹³



Conclusions This 10-year study documents the effectiveness of agalsidase beta (1 mg/kg/2 weeks) in patients with Fabry disease. Most patients remained alive and event-free. Patients who initiated treatment at a younger age and with less kidney involvement benefited the most from therapy. Patients who initiated treatment at older ages and/or had advanced renal disease experienced disease progression.



Long-term effectiveness of agalsidase alfa enzyme replacement therapy in Fabry disease: A Fabry Outcome Survey analysis

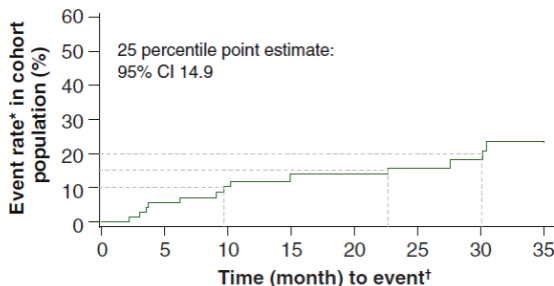
Michael Beck ^{a,*}, Derrallynn Hughes ^b, Christoph Kampmann ^c, Guillem Pintos-Morell ^d, Uma Ramaswami ^b, Michael West ^e
the Fabry Outcome Survey Study Group

Table 5

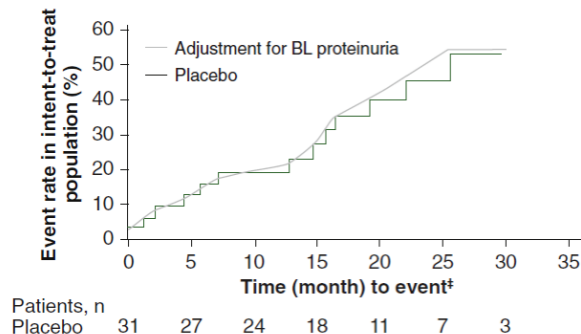
Progression of cardiomyopathy, determined by echocardiography, in male and female patients stratified by the presence of left ventricular hypertrophy (LVH)

Baseline LVH status		FOS Evaluable Treated Cardiac cohort	Mean annualized change in eGFR in male
		n	
Males			
Total	71	0.33 (0.10–0.56)	–3.0 (0.1)
LVH	29	0.19 (0.10–0.28)	–6.8 (1.5)
No LVH	42	0.47 (0.10–0.84)	–0.9 (0.9)
Females			
Total	93	0.48 (0.00–1.00)	–2.1 (1.6)
LVH	45	0.77 (0.49–1.00)	–6.9 (1.5)
No LVH	48	0.19 (0.00–0.40)	–3.3 (1.8)

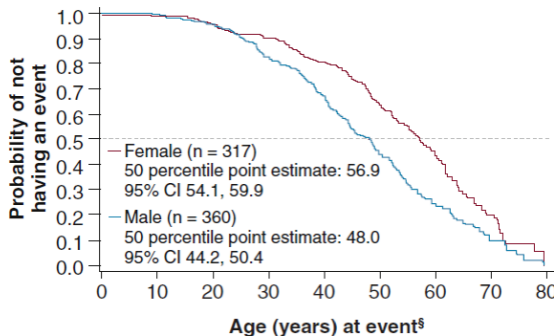
a FOS Evaluable Treated Morbidity Cohort
(n = 79, 48% male)



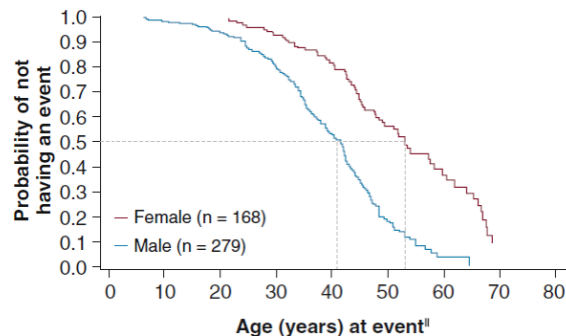
Banikazemi et al. Evaluable Populations (Untreated) [20]
(n = 31, 87% male)



b FOS Evaluable Treated Cohort
(n = 677)



Schiffmann et al. Population (Untreated) [21]
(n = 447)



in eGFR in male

et al.

) [21]

in/1.73 m²/y

–3.0 (0.1)

–6.8 (1.5)

–0.9 (0.9)

–2.1 (1.6)

–6.9 (1.5)

–3.3 (1.8)

–1.6 (1.5)

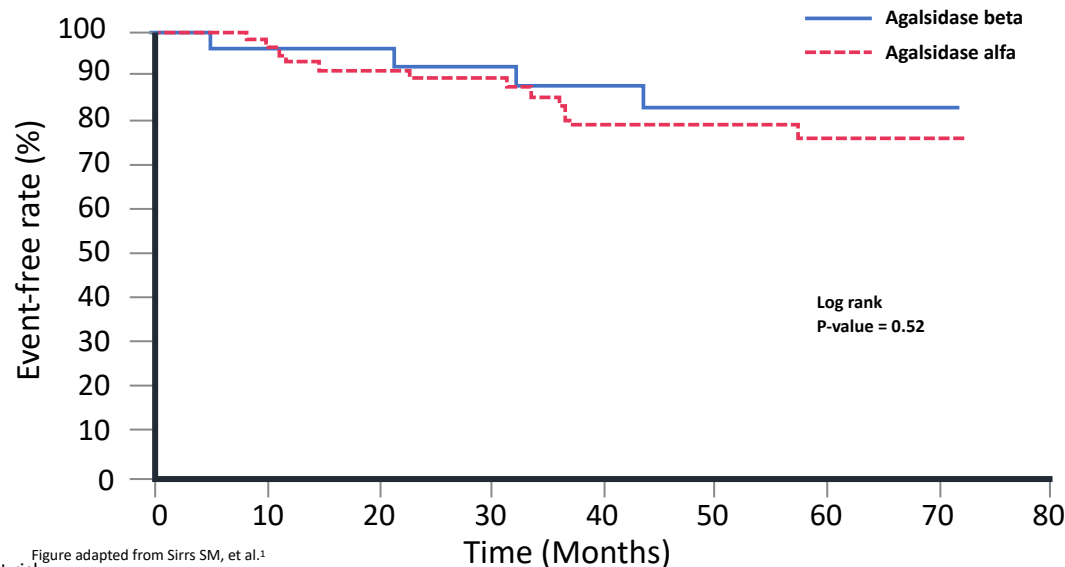
–4.6 (2.3)

–2.2 (2.2)

–0.6 (2.6)

CANADIAN FABRY DISEASE INITIATIVE

Kaplan–Meier plot showing composite clinical endpoint for patients on agalsidase alfa vs agalsidase beta (Cohort 1b)



For agalsidase alfa vs agalsidase beta

- Primary endpoint was met in 19.4% vs 13.3% of patients ($P=0.57$)
- Hazard ratio: 1.29 ($P=0.67$)

Cohort 1a Subjects receiving ERT prior to the start of the CFDI and are maintained on the ERT formulation (agalsidase alfa or agalsidase beta) at entry.

Cohort 1b Subjects naive to ERT who meet ERT criteria and undergo 1:1 randomization, stratified by gender, to either agalsidase alfa or agalsidase beta.

Cohort 1c Subjects naive to ERT who do not meet ERT criteria OR who do not consent to ERT. At any point, should a subject in Cohort 1c develop an indication for ERT, they are offered randomization into Cohort 1b.

ERT is given intravenously every other week using product monograph doses: agalsidase alfa 0.2 mg/kg and agalsidase beta 1 mg/kg.

Figure adapted from Sirrs SM, et al.³

Number at risk

Agalsidase beta	30	26	23	22	20	17	14	2
Agalsidase alfa	62	59	50	47	38	30	22	4

Reduction in kidney function decline and risk of severe clinical events in agalsidase beta-treated Fabry disease patients: a matched analysis from the Fabry Registry

Clinical trials of agalsidase beta may not be generalizable to all Fabry patients and do not address long-term outcomes. This analysis investigates long-term eGFR changes and risk of clinical events with agalsidase beta treatment in real-world populations.

Methods



Patients:

Agalsidase beta-treated (Fabry Registry) and untreated patients (Natural History Study) aged ≥ 16 years



Outcomes:

- eGFR slope: change in eGFR over time
- Risk of composite clinical event: cardiovascular, cerebrovascular or renal event, or death



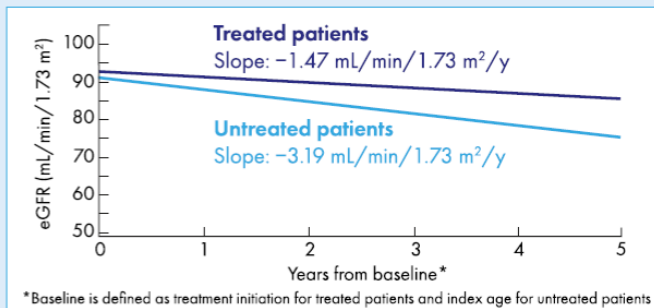
Analysis:

1:1 matching: untreated patients matched to similar treated patients to compare eGFR slopes and clinical events

Results

Estimated GFR slopes

53.9% reduction in rate of eGFR decline with agalsidase beta



Composite clinical event

59% lower risk of composite clinical event with agalsidase beta

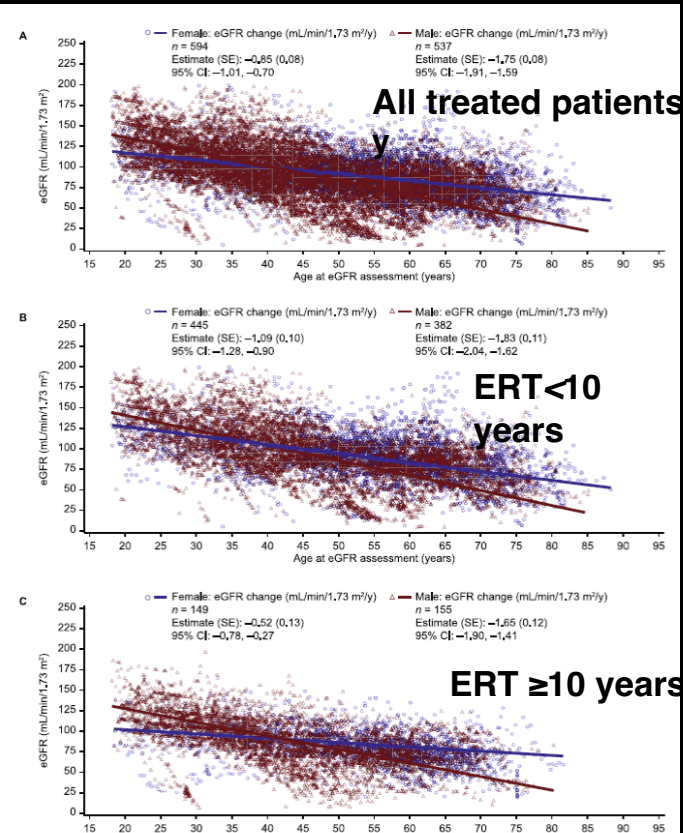
Conclusion: This real-world study provides evidence that long-term agalsidase beta treatment preserves kidney function and delays progression to severe clinical events among patients aged ≥ 16 years.

Batista, J. L.
Clinical Kidney Journal (2024)
Julie.Batista@sanofi.com
@CKJsocial

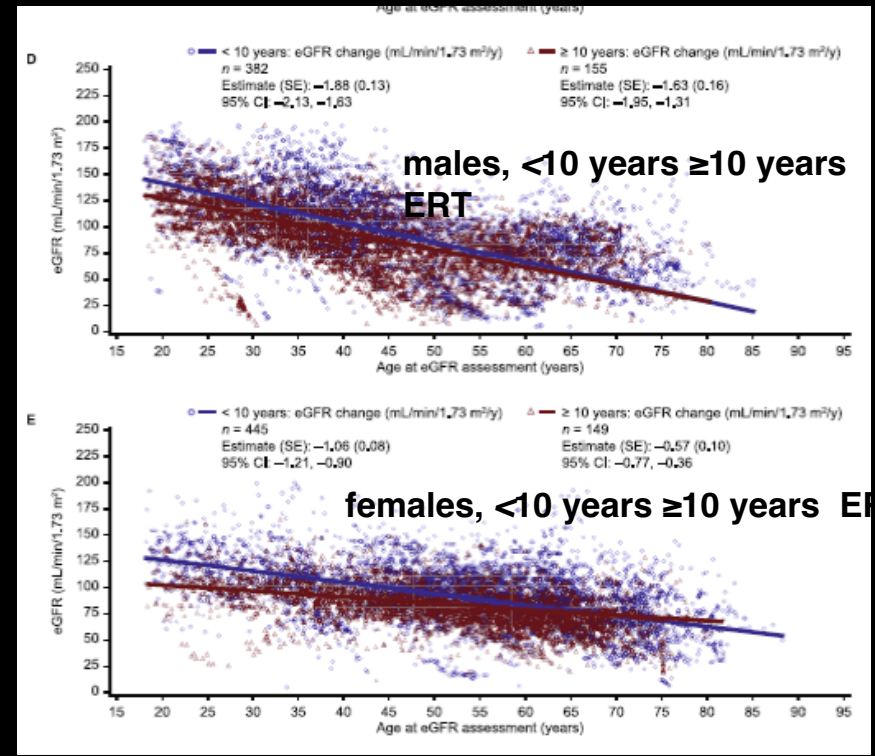
Two decades of experience of the Fabry Outcome Survey provides further confirmation of the long-term effectiveness of agalsidase alfa enzyme replacement therapy

Uma Ramaswami^a, Guillem Pintos-Morell^a, Christoph Kampmann^b, Kathleen Nicholls^c,
 Dai-Ming Niu^d, Ricardo Reisin^e, Michael L. West^f, Christina Anagnostopoulou^{g,h},
 Jacob Boffa^h, Dalia Jankevicieneⁱ, Jörn Schenk^{j,k}, Derryl A. Hughes^j, Roberto Giugliani^j

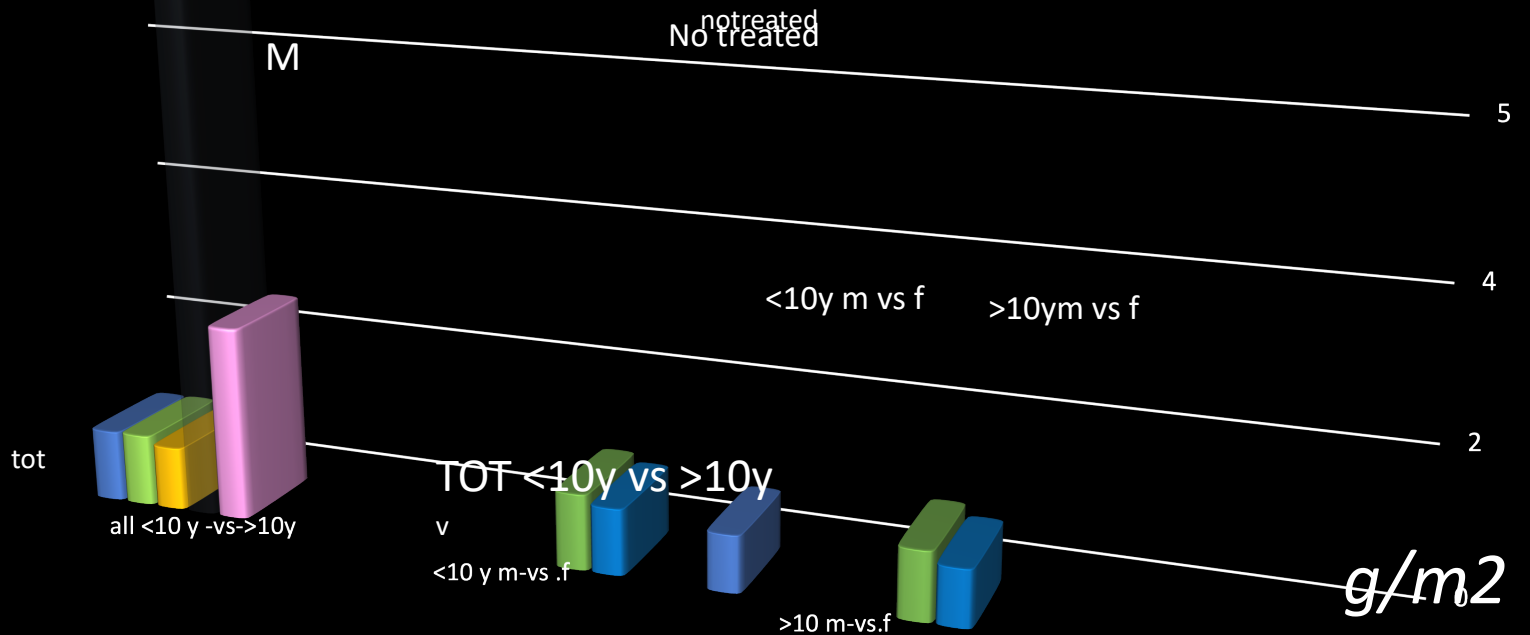
ANNUALISED eGFR CHANGE IN THE TREATED PATIENTS



Slope/
y
-0.85 f
-1.76



treated total vs no treated $p < 0.0001$



Conclusion: Migalastat was well tolerated and maintained stable renal and cardiac parameters with plasma lyso-Gb3 improvement. However, a subset of patients showed progression or intolerance, underscoring that variant amenability alone may not predict clinical benefit.

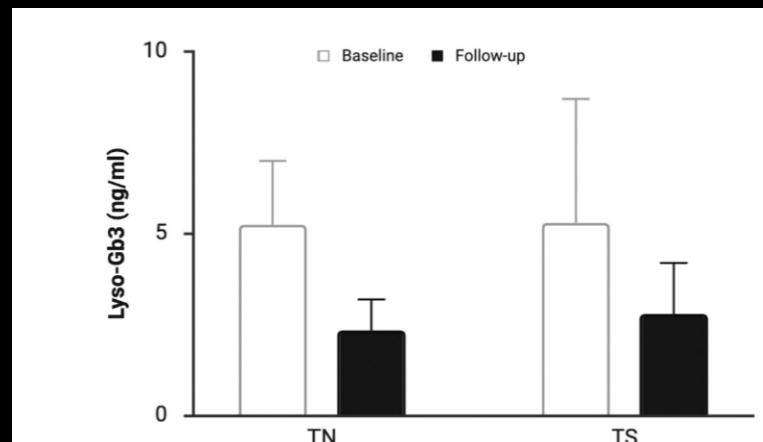


Table 3

Renal and cardiovascular parameters at baseline and follow-up in treatment-naïve and treatment-switch patients receiving migalastat.

Variables	Treatment naïve (N = 48)			Treatment switch (N = 39)		
	Baseline	Follow-up	p-Value	Baseline	Follow-up	p-Value
Biochemical						
eGFR >90, ml/min/1.73m ²	24/48 (50%)	14/48 (29%)	0.037	33/39 (84.6%)	12/39 (30.8%)	<0.001
eGFR >60, ml/min/1.73m ²	40/48 (83.3%)	34/48 (70.8%)	0.145	39/39 (100%)	35/39 (89.7%)	0.157
uPCR, mg/mmol	12 (7–21)	13 (8–30)	1.000	9 (7–16)	11 (5–19)	0.175
uACR, mg/mmol	3.7 (1.3–13.5)	4.55 (1.29–12.4)	0.343	1.8 (1–4.3)	2.15 (0.6–16)	0.564
Cardiovascular						
PR interval (ms)	158 (146–176)	169 (146–192)	0.067	156 (133–176)	163 (142.5–180.5)	0.063
QTc interval (ms)	435 (408–454.5)	444 (411–466.5)	0.319	418 (397.5–434)	442.5 (422–469)	<0.001
Systolic BP, mm Hg	133 (120–148)	132 (119–152)	0.257	133 (126–145)	129 (119–140)	0.060
Diastolic BP, mm Hg	80 (74–89)	82 (71–90)	0.301	80 (74–87)	82 (76–90)	0.340
Intraventricular septum at end-diastole (IVSd) (cm)	1.3 (1–1.7)	1.3 (1.2–1.65)	0.308	1.3 (0.96–1.6)	1.4 (1.2–1.7)	0.214
LVM (g)	224.6 (176.6–328.6)	237.1 (173.45–299.4)	0.739	233.5 (175.8–303.4)	219.1 (176.5–257.6)	0.110
LVMI (g/m ²)	110.9 (93.1–154.6)	113.8 (93–161.8)	0.736	121.7 (96.1–138.7)	105.3 (90.8–136.3)	0.088

RESEARCH

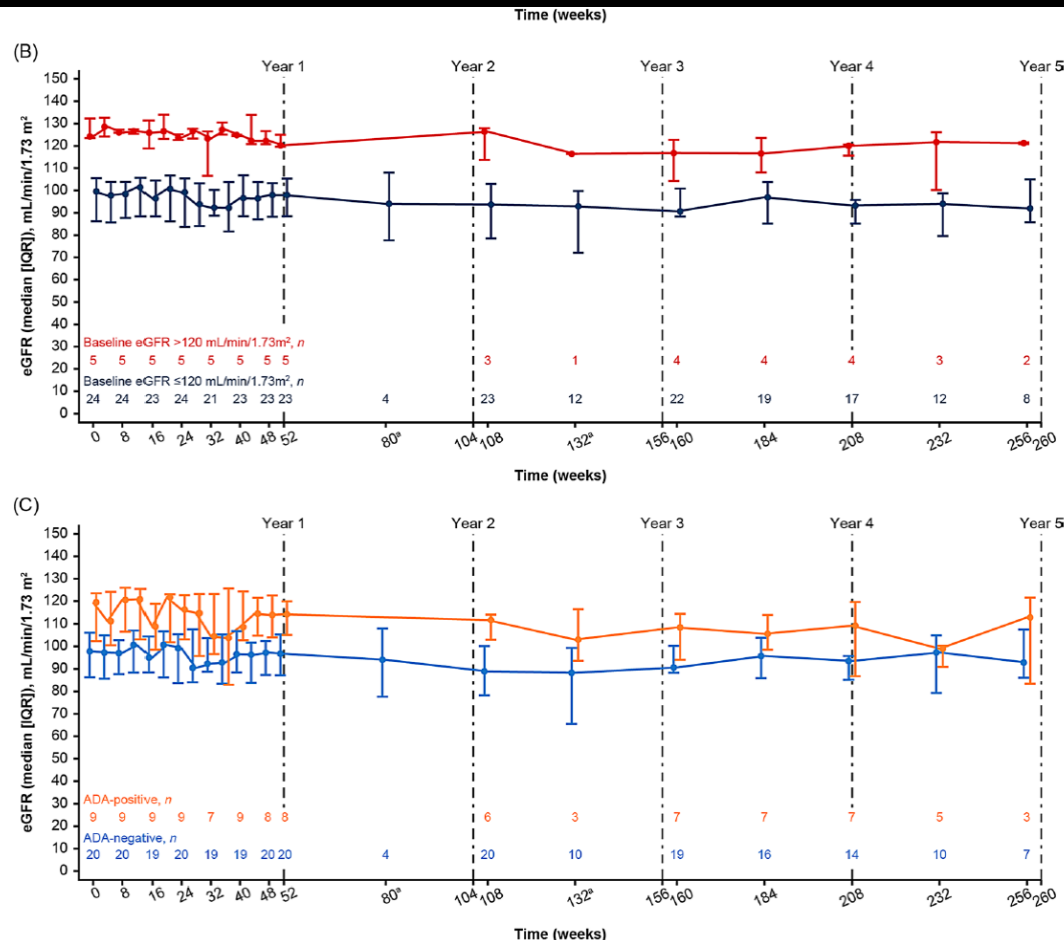
Open Access



Long-term efficacy and safety of pegunigalsidase alfa administered every 4 weeks in adults with Fabry disease: results from up to 5 years of the BRIGHT F51 phase III, open-label extension study

Myri Holida¹, Aleš Linhart², Nicola Longo², Eric Wallace⁴, Camilla Tondel⁵, Derrilyn Hughes⁶, David G. Warnock⁴, Antonio Pisani⁷, François Eyskens⁸, Patrick Deegan⁹, Ulla Feldt-Rasmussen¹⁰, Özlem Goker-Alpan¹¹, Ankit Mehta¹², Giovanni Pizzi¹³, Vito Fichera¹⁴, Meng Wang¹⁵, Raul Chertkoff¹⁶, Stephen Waldek¹⁵, William R. Wilcox¹⁶ and John A. Bemat¹⁷✉

Long-term treatment with pegunigalsidase alfa 2 mg/kg E4W was well-tolerated and Maintained disease stability, especially in females and ADA-negative males; more data are needed to better understand outcomes in ADA-positive males.



Prompt Agalsidase Alfa Therapy Initiation is Associated with Improved Renal and Cardiovascular Outcomes in a Fabry Outcome Survey Analysis

Drug Design, Development and Therapy 2021:15 3561–3572

Derralynn Hughes¹

Aleš Linhart²

Andrey Gurevich³

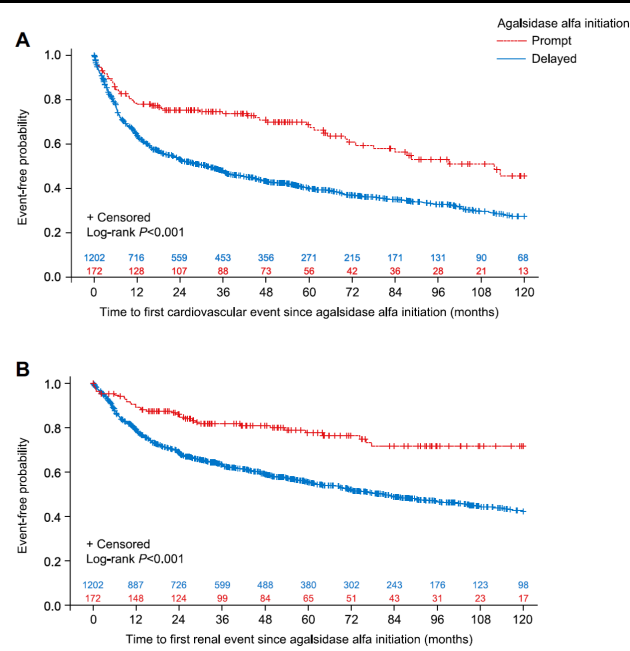
Vasiliki Kalampoki³

Dalia Jazukeviciene³

Sandro Feriozzi⁴

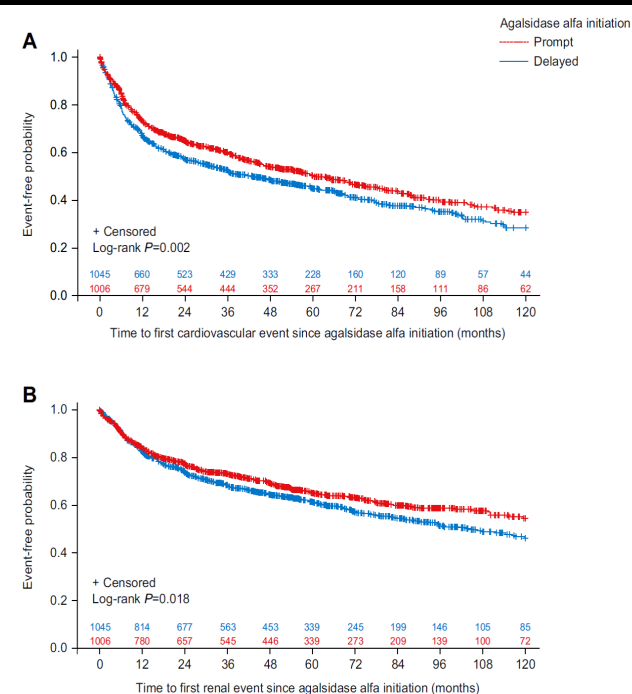
On behalf of the FOS Study Group

“This study suggests that prompt treatment initiation with agalsidase alfa provided better renal and cardiovascular outcomes than delayed treatment in patients with Fabry disease.”



Analysis A: Prompt and Delayed Treatment Since Symptom Onset

Analysis B: Prompt and Delayed Treatment Since Diagnosis



CLINICAL AND LAB HISTORY OF AN ITALIAN-GREEK BOY

Male date of birth 30/3/2008; in 2017 he received a diagnosis of Fabry disease; his mother and sister bearing classical pathogenetic mutation C1871T>C (Namazanova-Buroma 2016 Mol Genet Metab 120:S101) AGAL 0 (nv >2.3) umol/L/h

Organ	2017 / 9 yo	2018	2019	2022	2026	
heart	Echo normal range		Normal range	Normal range	Normal range	
Brain/eye	Cornea verticillata	Angio MR neg		Angio MR neg		
Kidney Scr eGFR Microalb	0,45 142 Neg	0,42 155 Neg	0,43 157 Neg	0,43 167 Neg	0,6 144	mg/dl ml/min/1.73/ m2
Peripheral nervous system	hypoidrosis	hypoidrosis	No	no		
Lyso Gb3		166	ERT Agalsidase A	36,8 ERT Agalsidase A	25ng ERT Agalsidase A	ng/ml

EARLY START OF ENZYME REPLACEMENT THERAPY IN PEDIATRIC MALE PATIENTS WITH CLASSICAL FABRY DISEASE IS ASSOCIATED WITH ATTENUATED DISEASE PROGRESSION

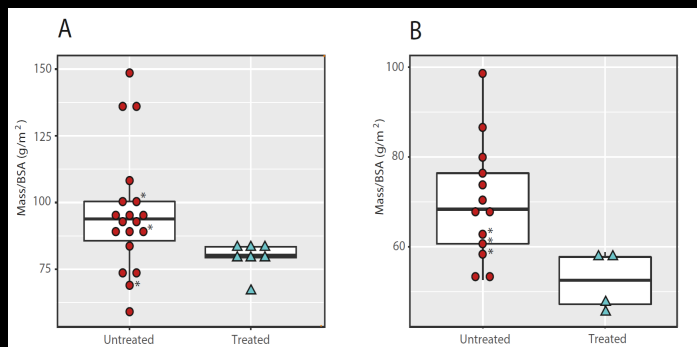
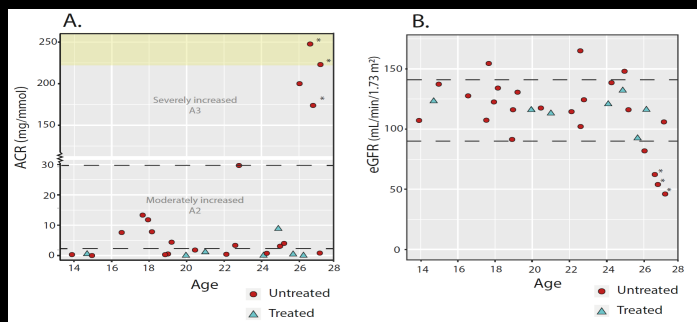


Table 1

Patient characteristics. Categorical variables are depicted as number (percentage) and continuous variables as median (range). Missing values (if any): presence of cornea verticillata (n = 2), reason unknown.

	Treated	Untreated	P-value
No of patients	7	23	
Age at evaluation (years)	24 (14–26)	22 (13–27)	0.7
Treatment duration (years)	10.4 (9.5–10.7)	–	
Mutation type			
Nonsense/Frameshift	4/7 (57%)	10/23 (43%)	1.0
Missense	3/7 (43%)	11/23 (48%)	
Other	0/7 (0%)	2/23 (9%)	
Reason for diagnosis			
Family screening	5/7 (71%)	10/23 (43%)	0.5
Acroparesthesia	2/7 (29%)	10/23 (43%)	
Renal insufficiency or albuminuria ^a	0/7 (0%)	3/23 (13%)	
Untreated plasma lysoGb3 (nmol/l)	118 (89–215) ^b	102 (65–137)	0.07
Clinical features of classical FD (at diagnosis)			
Acroparesthesia	7/7 (100%)	22/23 (96%)	1.0
Angiokeratomas	4/7 (57%)	17/23 (74%)	0.6
Cornea verticillata	6/7 (86%)	17/21 (81%)	1.0
Hypertension	0/7 (0%)	1/23 (4%) ^c	1.0
Use of ACEi or ARB	0/7 (0%)	4/23 (17%)	0.5

Reproduced from van der Veen SJ, et al. 2022

"...to provide clinical evidence that treatment of male cFD patients before the age of 16 has a beneficial impact on progression..."

Figures reproduced from van der Veen SJ, et al. 2022

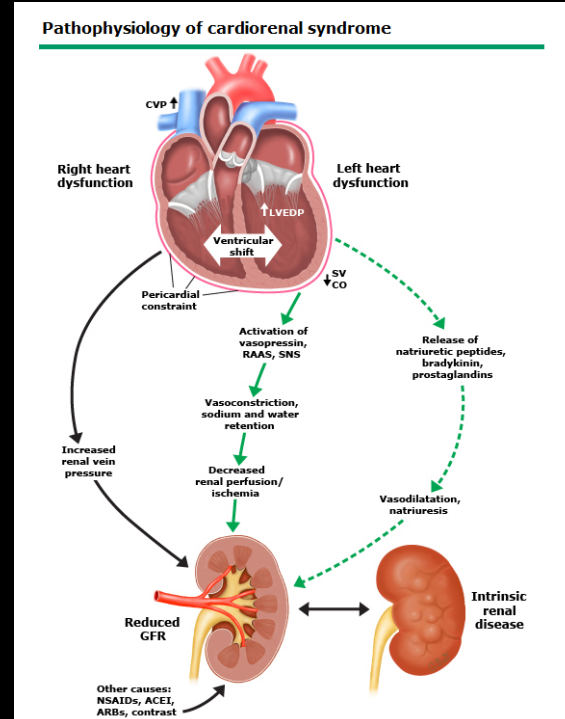
ACEi, angiotensin-converting enzyme inhibitor; ACR, albumin-to-creatinine ratio; ARB, angiotensin receptor blocker; BSA, body surface area; cFD, classical disease phenotype of Fabry disease; eGFR, estimated glomerular filtration rate; FD, Fabry disease; lyso-Gb3, globotriaosylsphingosine.

van der Veen, SJ, et al. *Mol Genet Metab.* 2022;135(2):163–169.

van der Veen, *Mol Genet Metab.* 2022.

CARDIORENAL SYNDROME

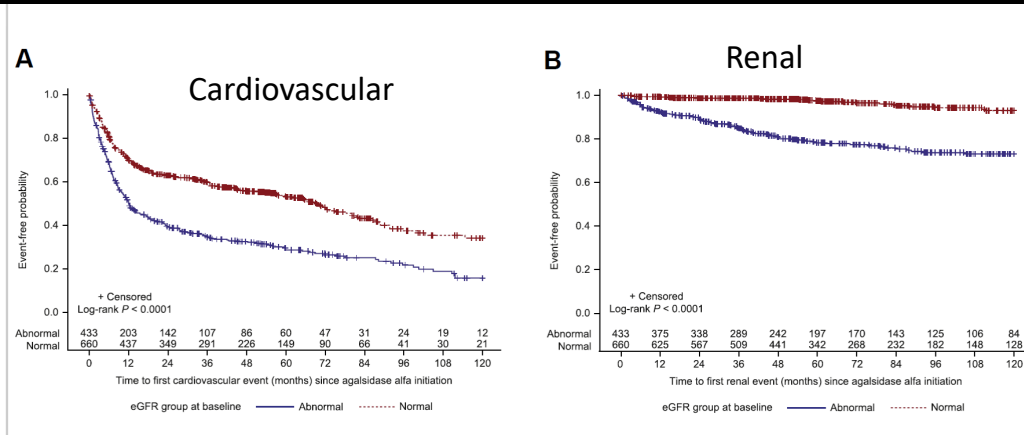
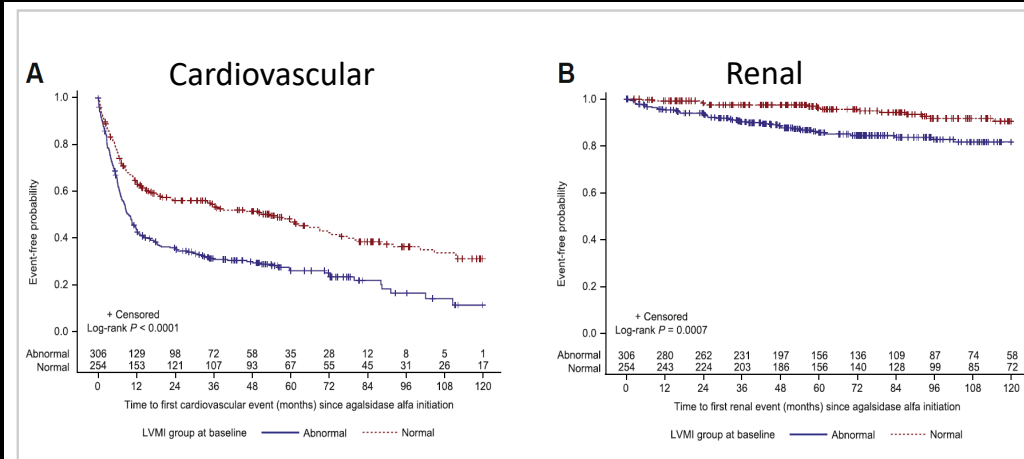
- *Type 1 (acute)* – Acute HF results in AKI
- *Type 2 – Chronic cardiac dysfunction* causes chronic kidney disease (CKD)).
- *Type 3 – Abrupt and primary worsening of kidney function* Ex. renal ischemia or glomerulonephritis with acute cardiac dysfunction
- *Type 4 – Primary CKD* with contributes to cardiac dysfunction
- *Type 5 (secondary)* – *Acute or chronic systemic disorders* (eg, sepsis or diabetes mellitus) that cause both cardiac and renal dysfunction.



CARDIOVASCULAR AND RENAL EVENTS

Occurrence of events
in patients with or
without LVH

*The findings suggest that cardiovascular
and renal pathologies are closely inter-related*



Occurrence of events
in patients with low
or normal GFR

ADDITIONAL EVIDENCE IN LITERATURE

RESEARCH ARTICLE

Retrospective study of long-term outcomes of enzyme replacement therapy in Fabry disease: Analysis of prognostic factors

Maarten Arends^{1*}, Marieke Biegstraaten¹, Derralynn A. Hughes², Atul Mehta², Perry M. Elliott³, Daniel Oder⁴, Oliver T. Watkinson³, Frédéric M. Vaz⁵, André B. P. van Kuilenburg¹, Christoph Wanner¹, Carla E. M. Hollak¹

PLOS ONE | <https://doi.org/10.1371/journal.pone.0182379> August 1, 2017

Table 5. Multivariate analysis.

	HR	95% CI
eGFR (per -10 ml/min/1.73m ²)	1.12 ^{††}	1.03–1.22
LVMI (per 10 gram/m ^{2.7})	1.16	0.99–1.36
Event(s) before ERT	1.45	0.85–2.53

Cox regression analysis on the clinical event rate, adjusted for age, sex and phenotype. The hazard ratios (HR) of eGFR, LVMI and events before ERT on the clinical event rate were calculated in a multivariate model. Number of patients included in the analysis: 233. eGFR: estimated glomerular filtration rate, LVMI: left ventricular mass index measured by echocardiography adjusted for height^{2.7}, ERT: enzyme replacement therapy.

^{††}p < 0.01;

«the multivariate analysis....

- eGFR independently resulted in an increased clinical event rate. ...a trend towards an increased event rate with higher LVMI»

Downloaded from <http://heart.bmj.com/> on February 9, 2015 - Published by group.bmj.com

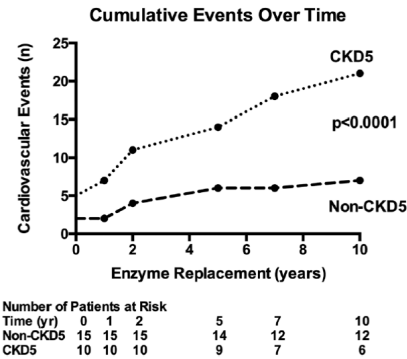
Heart 2015;101:287–293.

Special populations

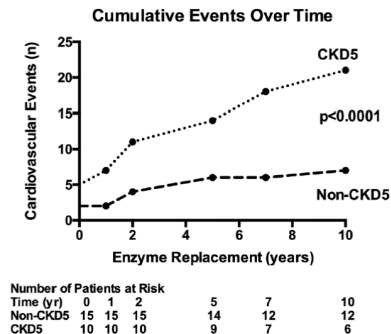
ORIGINAL ARTICLE

Cardiovascular outcomes in Fabry disease are linked to severity of chronic kidney disease

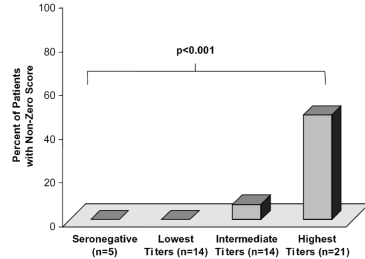
Andrew S Talbot,¹ Nigel T Lewis,² Kathy M Nicholls^{1,3}



- «ESRD was the strongest indicator of cardiovascular progression
- ERT was associated with stability in cardiac and renal disease



Impact of IgG antibodies to α Gal- β on tissue storage: **increase of skin GL-3**



ORIGINAL ARTICLE

Agalsidase alfa versus agalsidase beta for the treatment of Fabry disease: an international cohort study

Maarten Arends,¹ Marieke Biegstraaten,¹ Christoph Wanner,² Sandra Sirrs,³ Atul Mehta,⁴ Perry M Elliott,^{5,6} Daniel Oder,² Oliver T Watkinson,^{5,6} Daniel G Bichet,⁷ Aneal Khan,⁸ Mark Iwanochko,⁹ Frédéric M Vaz,¹⁰ André B P van Kullenburg,¹¹ Michael L West,¹¹ Derrilyn A Hughes,⁸ Carla E M Hollak¹

J Med Genet 2018;**55**:351–358. doi:10.1136/jmedgenet-2017-104863

ADA

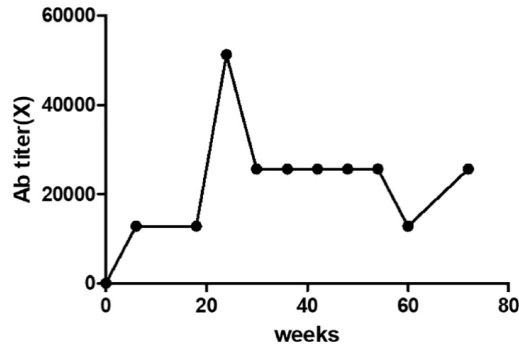


Table 1 Patient characteristics at start of ERT

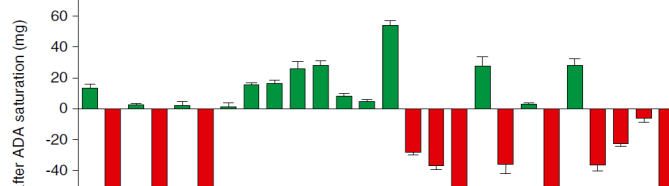
	Agalsidase alfa (0.2 mg/kg)	Agalsidase beta (1.0 mg/kg)	P value
Patients	248	139	
Men, classical*	69 (28%)	71 (51%)	<0.001
Men, non-classical	47 (19%)	7 (5%)	0.22
Women, classical	95 (38%)	43 (30%)	0.14
Women, non-classical	37 (15%)	18 (13%)	0.86
ERT start <18 years of age	15 (6%)	3 (2%)	0.13
Follow-up time (years)	5.2 (0.8–14.4)	3.8 (0.8–12.1)	<0.001
Events before initiation of ERT			
Dialysis/renal transplant	8 (3%)	12 (9%)	0.007
PM/ICD	21 (8%)	9 (7%)	0.87
Stroke	22 (9%)	17 (12%)	0.09
Any of the above†	46 (19%)	31 (22%)	0.08
LysoGb3 (nmol/L)	10 (0.7–146)	80 (2.0–178)	<0.001
eGFR (mL/min/1.73 m ²)	89 (10–159)	86 (10–140)	0.009
CKD category A3	44/195 (23%)	42/113 (37%)	0.008
LVMI (g/m ^{2.7})	49 (15–117)	52 (20–148)	0.14
Use of ACEi/ARBs	89/248 (36%)	52/139 (37%)	0.83
Hypertension	109/236 (39%)	62/137 (45%)	0.23
BMI (kg/m ²)	26 (±4.9)	25 (±5.6)	0.30
HDL cholesterol (mmol/L)	1.5 (±0.4)	1.5 (±0.4)	0.92
LDL cholesterol (mmol/L)	2.7 (±0.9)	2.7 (±0.8)	0.76
Total cholesterol (mmol/L)	4.8 (±1.1)	4.7 (±1.0)	0.51
Triglycerides (mmol/L)	1.2 (0.2–5.9)	1.2 (0.3–3.6)	0.18

Male classical phenotype #81:
11 of 39 agalsidase-alfa- (28%)
22 of 42 (52%) were positive for

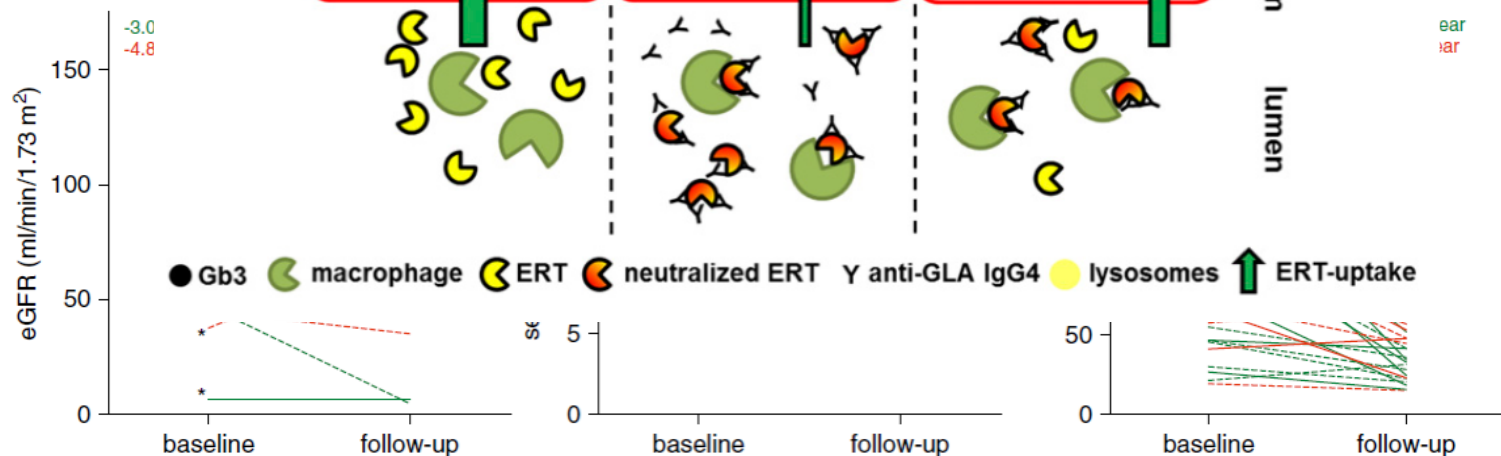
Konto Mol Gen Met 2020

Dose-Dependent Effect of Enzyme Replacement Therapy on Neutralizing Antidrug Antibody Titers and Clinical Outcome in Patients with Fabry Disease

Malte Lenders,¹ Leon Paul Neuffer,¹ Michael Rudnicki,² Peter Nordbeck,³ Sima Canaan-Kühl,⁴ Albina Nowak,⁵ Markus Cybulla,⁶ Boris Schmitz,⁷ Jan Lukas,⁸ Christoph Wanner,³ Stefan-Martin Brand,⁷ and Eva Brand¹

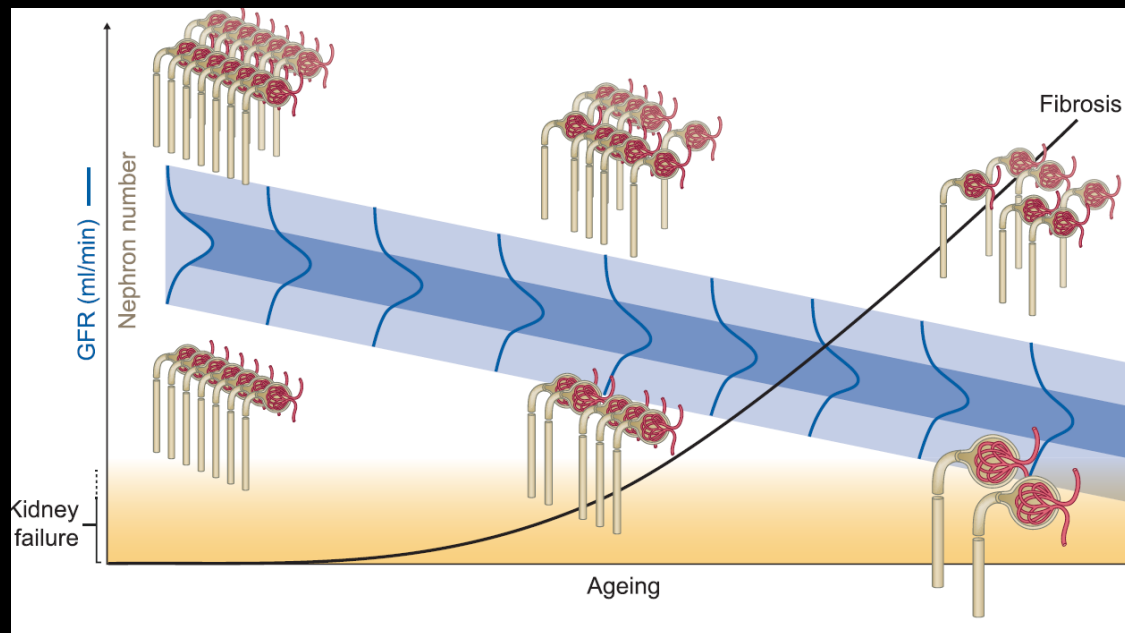


A



SGLT2 inhibition requires reconsideration of fundamental paradigms in chronic kidney disease, 'diabetic nephropathy', IgA nephropathy and podocytopathies with FSGS lesions

Hans-Joachim Anders¹, Anna Julie Peired^{2,3} and Paola Romagnani^{1,4}

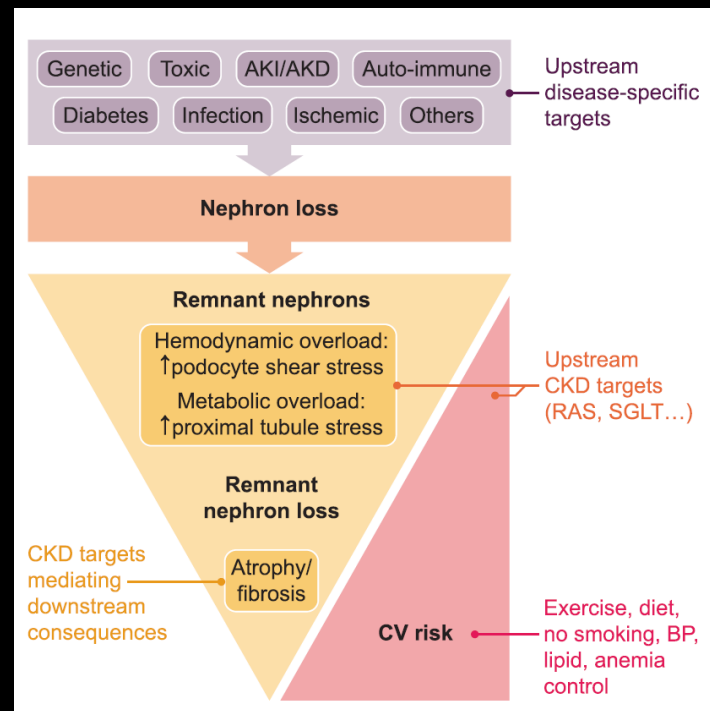


Healthy ageing:

Declining nephron number/GFR
+ fibrosis still match body needs
= **normal** nephron dimensions

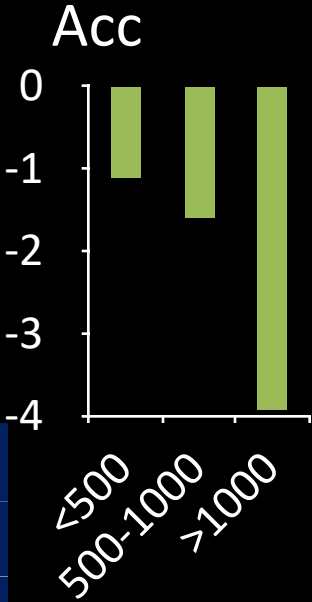
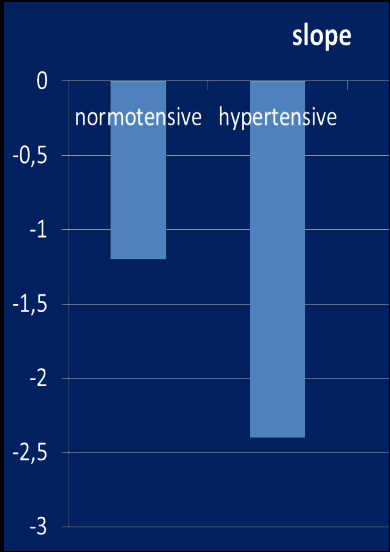
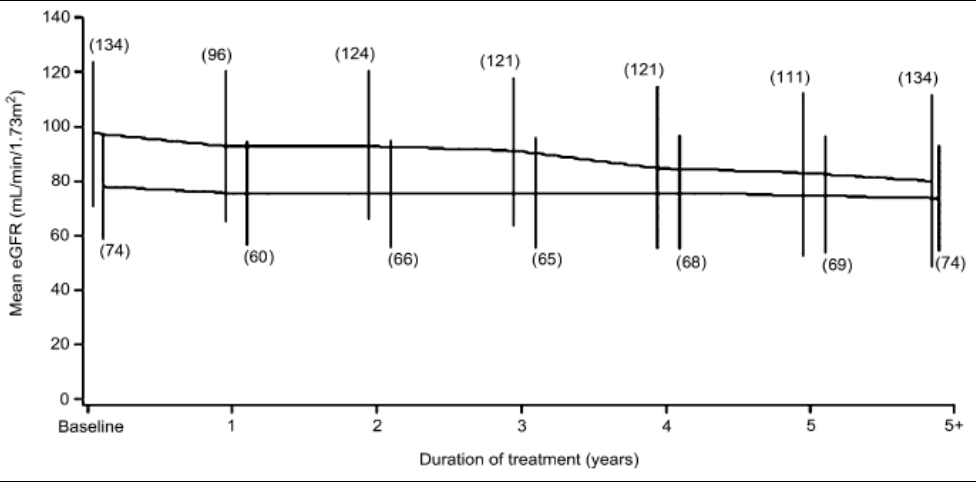
Chronic kidney disease:

Nephron number/GFR + fibrosis
no longer match body needs
= functional overload of remnant
nephrons, which triggers
structural adaptations that drive
further nephron loss
= CKD progression



The Effectiveness of Long-Term Agalsidase Alfa Therapy in the Treatment of Fabry Nephropathy

Sandro Feriozzi,^{*} Joan Torras,[†] Markus Cybulla,[‡] Kathy Nicholls,[§] Gere Sunder-Plassmann,^{||} and Michael West,[¶]
on behalf of the FOS Investigators



ANTI- PROTEINURIC THERAPIES

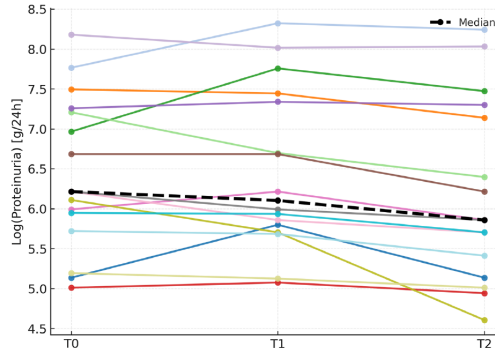
KI REPORTS

ARTICLE IN PRESS

CLINICAL RESEARCH

Dapagliflozin in Patients With CKD With Fabry Disease

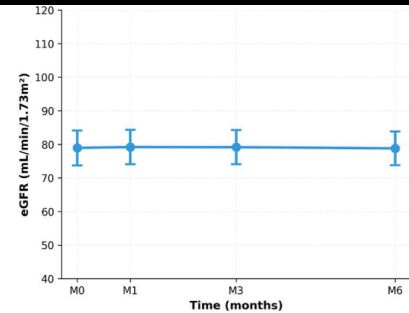
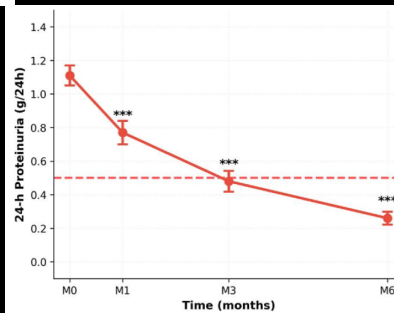
Yuri Battaglia^{1,2,13}, Nicola Vitturi^{1,13}, Giacomo Marchi⁴, Federica Baciga^{1,2}, Federica Caccia¹, Giorgia Gugelmo⁵, Loris Martinetti⁶, Lucia Federica Stefanelli⁸, Sara Torresani⁹, Antonio Pisani¹⁰, Eleonora Riccio², Pasquale Esposito⁵, Francesca Viazzi⁷, Cristina Chimenti¹⁰, Francesca Katiana Martino¹⁰, Livia Lenzini¹⁰, Annalisa Sechi¹⁰, Luca Zanolli^{11,12}, Domenico Girelli¹⁰, Gian Paolo Fadini¹⁰, Federico Nalesso^{11,12} and Gianni Carraro¹⁰



> Nephrol Dial Transplant. 2026 May 20:gfa115. doi: 10.1093/ndt/gfa115. Online ahead of print.

DUAL GIP/GLP-1Ra reduces residual proteinuria in non-diabetic fabry disease

Eleonora Riccio¹, Alessandra Cuomo², Ivana Capuano¹, Letizia Spinelli², Guido Iaccarino², Oriana De Marco³, Antonio Pisani¹

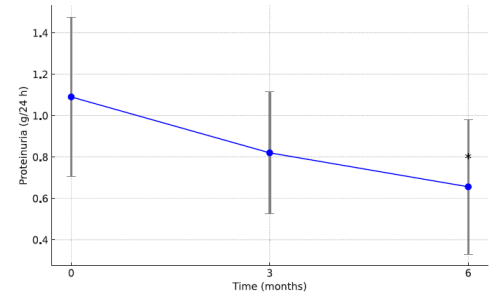


Nephrol Dial Transplant, 2025, 40, 1989–1990
<https://doi.org/10.1093/ndt/gfa088>
 Advance access publication date: 8 May 2025

Semaglutide in non-diabetic patients with Fabry disease

Eleonora Riccio, Ivana Capuano and Antonio Pisani

Department of Public Health, Chair of Nephrology, University Federico II of Naples, Naples, Italy
 Correspondence to: Eleonora Riccio; E-mail: Eleonora.riccio@gmail.com



* p < 0.05 vs month 0

CONCLUSION

- The studies and the registries provided robust basic evidence for Fabry disease therapy
- Real life and the researchers' improving of direct expertise led to a focus on some critical points.
- At present, the availability of different therapeutic options is challenging to target to individual patients.
- New medications for the supportive therapy are now available to prevent chronic organ damage.