STUDY Medical Treatment of Hypercortisolism with Relacorilant: Final Results of the Phase 3 GRACE Study

Pivonello, Rosario; Arnaldi, Giorgio; Auchus, Richard J.; Badiu, Corin; Busch, Robert; Cannavo, Salvatore; Dischinger, Ulrich; Dobri, Georgiana A.; Donegan, Diane M.; Elenkova, Atanaska[;] Fazeli, Pouneh K.; Feelders, Richard A.; Garcia-Centeno, Rogelio; Gilis-Januszewska, Aleksandra; Hamidi, Oksana; Hannoush, Zeina C.; Miller, Harold J.; Ranetti, Aurelian-Emil; Recasens, Monica; Reincke, Martin; Rovner, Sergio; Salvatori, Roberto; Silverstein, Julie; Stigliano, Antonio; Terzolo, Massimo; Wang, Christina; Yuen, Kevin C.J.; Hand, Austin L.; Tudor, Iulia Cristina; Araque, Katherine A.; Moraitis, Andreas G. on behalf of the GRACE investigators

Relacorilant: In Development for the Treatment of Cushing Syndrome



ACTH, adrenocorticotropic hormone; AR, androgen receptor; GR, glucocorticoid receptor; MR, mineralocorticoid receptor; PR, progesterone receptor.

The GRACE Phase 3 Study



NCT03697109. ABPM, ambulatory blood pressure monitoring; BL, baseline; DBP, diastolic blood pressure; HbA1c, hemoglobin A1c; oGTT, oral glucose tolerance test; OL, open label; QD, every day; RW, randomized withdrawal; SBP, systolic blood pressure. *Patients with hypertension and hyperglycemia who do not meet the response criteria for both must meet the response criteria without worsening of the other comorbidity.

Patient Demographics & Baseline Characteristics

Mean (SD)	Hypertension only (n=31)	Hyperglycemia only (n=50)	Hypertension & hyperglycemia (n=71)	Overall (N=152)
Age, yrs	43.5 (11.6)	54.1 (13.7)	50.9 (12.6)	50.4 (13.2)
Female, n (%)	24 (77.4)	42 (84.0)	61 (85.9)	127 (83.6)
Weight, kg	95.2 (25.5)	91.1 (21.4)	95.0 (26.6)	93.8 (24.7)
BMI, kg/m²	33.4 (7.5)	34.8 (7.9)	35.3 (9.6)	34.7 (8.6)
Waist circumference, cm	112.8 (17.4)	114.4 (14.7)	116.1 (20.4)	114.9 (18.0)
ACTH-dependent, n (%)	23 (74.2)	39 (78.0)	56 (78.9)	118 (77.6)
Plasma ACTH, pg/mL [n] 24-h UFC, μg/d [n]	67.7 (34.0) [23] 191.2 (221.8) [18]	74.9 (85.0) [39] 148.0 (136.3) [26]	78.1 (69.9) [56] 257.9 (407.1) [39]	74.9 (69.8) [118] 209.0 (308.3) [83]
ACTH-independent, n (%)	8 (25.8)	11 (22.0)	15 (21.1)	34 (22.4)
Plasma ACTHª, pg/mL [n] 24-h UFC, μg/d [n]	7.3 (4.8) [8] 108.3 (88.9) [6]	20.0 (26.6) [11] 68.7 (67.9) [7]	10.0 (6.2) [15] 61.3 (30.5) [8]	12.7 (16.2) [34] 77.2 (64.0) [21]
Mean 24-h SBP (mm Hg) [n]	138.1 (9.4) [30]	124.6 (9.0) [47]	141.6 (11.0) [71]	135.5 (12.6) [148]
Mean 24-h DBP (mm Hg) [n]	90.8 (5.7) [30]	76.0 (7.3) [47]	88.1 (7.6) [71]	84.8 (9.4) [148]
HbA1c (%)	5.4 (0.5)	7.1 (1.6)	7.2 (1.6)	6.8 (1.6)

^aMedian ACTH was <5 pg/mL (hypertension only); 9 pg/mL (hyperglycemia only, hypertension and hyperglycemia, and overall). ACTH, adrenocorticotropic hormone; BMI, body mass index; DBP, diastolic blood pressure; OL, open-label phase; SBP, systolic blood pressure; SD, standard deviation; UFC, urinary free cortisol.

Open-label Results



Patients with hypertension



ABPM, ambulatory blood pressure monitoring; BL, baseline; DBP, diastolic blood pressure; LSM, least squares mean; SBP, systolic blood pressure; SE, standard error. Error bars: SE of the mean. LSM and SE calculated using a linear mixed model for repeated measures (MMRM). Wilcoxon rank sum test p-values for the mean change from baseline shown.

Patients with hypertension who took blood pressure medications



ABPM, ambulatory blood pressure monitoring; BL, baseline; DBP, diastolic blood pressure; LSM, least squares mean; SBP, systolic blood pressure; SE, standard error. Error bars: SE of the mean. LSM and SE calculated using a linear mixed model for repeated measures (MMRM). Wilcoxon rank sum test p-values for the mean change from baseline shown.

Patients with hypertension who did not take blood pressure medications



ABPM, ambulatory blood pressure monitoring; BL, baseline; DBP, diastolic blood pressure; LSM, least squares mean; ns, not significant (*P*≥0.05); SBP, systolic blood pressure; SE, standard error. Error bars: SE of the mean. LSM and SE calculated using a linear mixed model for repeated measures (MMRM). Wilcoxon rank sum test p-values for the mean change from baseline shown.

Patients with systolic hypertension



ABPM, ambulatory blood pressure monitoring; BL, baseline; DBP, diastolic blood pressure; LSM, least squares mean. SBP, systolic blood pressure; SE, standard error. Error bars: SE of the mean. LSM and SE calculated using a linear mixed model for repeated measures (MMRM). Wilcoxon rank sum test p-values for the mean change from baseline shown.

Patients with diastolic hypertension



ABPM, ambulatory blood pressure monitoring; BL, baseline; DBP, diastolic blood pressure; LSM, least squares mean; SBP, systolic blood pressure; SE, standard error. Error bars: SE of the mean. LSM and SE calculated using a linear mixed model for repeated measures (MMRM). Wilcoxon rank sum test p-values for the mean change from baseline shown.

Improvements in Day- and Nighttime Blood Pressure by ABPM With Relacorilant

Patients with hypertension



ABPM, ambulatory blood pressure monitoring; BL, baseline; DBP, diastolic blood pressure; LSM, least squares mean; SBP, systolic blood pressure; SE, standard error. Error bars: SE of the mean. LSM and SE calculated using a linear mixed model for repeated measures (MMRM). Wilcoxon rank sum test p-values for the mean change from baseline shown.

Patients with hypertension who met hypertension response criteria & entered the RW phase



ABPM, ambulatory blood pressure monitoring; BL, baseline; DBP, diastolic blood pressure; LSM, least squares mean; SBP, systolic blood pressure; SE, standard error. Error bars: SE of the mean. LSM and SE calculated using a linear mixed model for repeated measures (MMRM). Wilcoxon rank sum test p-values for the mean change from baseline shown.

Open-label Results



Rapid and Sustained Improvements in AUC_{glucose} With Relacorilant

Patients with hyperglycemia (IGT or DMb)



^aMean change from baseline to visit OL 22: -3.3 h*mmol/L. ^bDiabetes defined as fasting plasma glucose ≥126 mg/dL, 2-h oGTT plasma glucose ≥200 mg/dL, or HbA1c ≥6.5%.

AUC_{glucose}, glucose area under the curve; BL, baseline; DM, diabetes mellitus; hemoglobin A1c; HbA1c, hemoglobin A1c; IGT, impaired glucose tolerance; LSM, least squares mean; ns, not significant (*P*≥0.05); oGTT, oral glucose tolerance test; SE, standard error. Error bars: SE of the mean. LSM and SE calculated using a linear mixed model for repeated measures (MMRM). Wilcoxon rank sum test *P*-values for the mean change from baseline shown.

Rapid and Sustained Improvements in AUC_{glucose} With Relacorilant

Patients with diabetes (DM)^b

 $\mathsf{AUC}_{\mathsf{glucose}}$ -SM change from BL in AUC_{glucose} (h*mmol/L) 0 -1 **-3.8**ª -2 -3 -4 -5 **Baseline** Week Week Week Week Week 18 22 10 14 6 88 74 70 54 45 47 n: P-value: 0.0003 < 0.0001 < 0.0001 0.04 ns

^aMean change from baseline to visit OL 22: -4.7 h*mmol/L. ^bDiabetes defined as fasting plasma glucose \geq 126 mg/dL, 2-h oGTT plasma glucose \geq 200 mg/dL, or HbA1c \geq 6.5%.

AUC_{glucose}, glucose area under the curve; BL, baseline; LSM, least squares mean; ns, not significant (*P*≥0.05); oGTT, oral glucose tolerance test; SE, standard error. Error bars: SE of the mean. LSM and SE calculated using a linear mixed model for repeated measures (MMRM). Wilcoxon rank sum test *P*-values for the mean change from baseline shown.

Rapid and Sustained Improvements in AUC_{glucose} With Relacorilant

Patients with hyperglycemia (IGT or DM^b) who met hyperglycemia response criteria & entered the RW phase

Open Label



^aMean change from baseline to visit OL 22: -6.2 h*mmol/L. ^bDiabetes defined as fasting plasma glucose ≥126 mg/dL, 2-h oGTT plasma glucose ≥200 mg/dL, or HbA1c ≥6.5%. AUC_{glucose}, glucose area under the curve; BL, baseline; DM, diabetes mellitus; HbA1c, hemoglobin A1c; IGT, impaired glucose tolerance; LSM, least squares mean; oGTT, oral glucose tolerance test; SE, standard error.

Error bars: SE of the mean. LSM and SE calculated using a linear mixed model for repeated measures (MMRM). Wilcoxon rank sum test P-values for the mean change from baseline shown.

Greater Improvements in Glucose Parameters With Relacorilant in Hyperglycemia Responders



^bDiabetes defined as fasting plasma glucose ≥126 mg/dL, 2-h oGTT plasma glucose ≥200 mg/dL, or HbA1c ≥6.5%.

BL, baseline; DM, diabetes mellitus; HbA1c, hemoglobin A1c; FPG, fasting plasma glucose; IGT, impaired glucose tolerance; LSM, least squares mean; oGTT, oral glucose tolerance test; SE, standard error. Error bars: SE of the mean. LSM and SE calculated using a linear mixed model for repeated measures (MMRM). Wilcoxon rank sum test *P*-values for the mean change from baseline shown.

Open-label Results other symptoms and comorbidities



Significant Improvements in Body Composition With Relacorilant



Open Label

BL, baseline; DXA, Dual Energy X-Ray Absorptiometry, OL, open label. Error bars: Standard deviation. Wilcoxon rank sum test P-values for the mean change from baseline shown.

Significant Improvements in Quality of Life and Cognitive Assessments With Relacorilant



BL, baseline, OL, open label; QOL, quality of life. Error bars: Standard deviation. Wilcoxon rank sum test P-values for the mean change from baseline shown.

Open-label Results



Adverse Event Summary

n (%)	Relacorilant (N=152)
Patients reporting at least one TEAE (any grade)	147 (96.7)
Patients reporting at least one grade ≥3 TEAE	37 (24.3)
TEAEs resulting in:	
Dose interruption Dose reduction Permanent withdrawal	50 (32.9) 50 (32.9) 24 (15.8)
Serious TEAEs	28 (18.4)
Treatment-related serious TEAEs	7 (4.6)
TEAEs leading to death ^a (none relacorilant related)	2 (1.3)

- Due to relacorilant's specificity for the GR and its unique mechanism of action, the observed efficacy was seen:
 - Without cases of relacorilant-induced irregular vaginal bleeding with endometrial hypertrophy
 - Without increases in cortisol concentrations and relacorilant-induced hypokalemia
 - Without reported cases of adrenal insufficiency
 - Without independently confirmed QT prolongation

Adverse Events Occurring in ≥10% of Patients

Among patients in the open-label phase

		Adverse event incidence rate (%)	
n (%)	Relacorilant	0 5% 10% 15% 20% 25% 30% 35%	
Nausea	52 (34.2)		
Edema peripheral	50 (32.9)		
Pain in extremity	43 (28.3)		• The majority of AEs were mild to
Back pain	41 (27.0)		
Fatigue	34 (22.4)		moderate in severity
Headache	31 (20.4)		
Arthralgia	30 (19.7)		 No new safety signals were
Diarrhea	28 (18.4)		identified
Skin hyperpigmentation	24 (15.8)		laontinoa
Abdominal pain upper	23 (15.1)		 The frequency of serious AFs
Constipation	23 (15.1)	Grade 1 Asymptomatic or	
Dizziness	23 (15.1)	mild; intervention	was low, with no dose-dependent
Myalgia	21 (13.8)	Grade 2	pattern
Paresthesia	21 (13.8)	Moderate; minimal,	
Asthenia	19 (12.5)	intervention indicated	
Vomiting	19 (12.5)	Grade 3	
Abdominal pain	17 (11.2)	significant but not	
Decreased appetite	17 (11.2)	immediately life threatening	
Muscular weakness	17 (11.2)		

TEAEs and CTCAE grade shown. AE, adverse event; CTCAE, Common Terminology Criteria for Adverse Events; OL, open label; TEAE, treatment-emergent adverse event.

Randomized-withdrawal Results



Patient Demographics & Baseline Characteristics

Mean (SD)	Relacorilant (n=30)	Placebo (n=32)
Age, yrs	46.6 (11.0)	48.8 (14.4)
Female, n (%)	22 (73.3)	26 (81.3)
Weight, kg	93.3 (27.4)	88.6 (21.1)
BMI, kg/m²	33.3 (7.6)	32.6 (6.5)
Waist circumference, cm	113.8 (17.7)	108.9 (17.1)
ACTH-dependent, n (%)	26 (86.7)	23 (71.9)
Plasma ACTH, pg/mL 24-h UFC, μg/d	91.7 (85.7) 257.1 (449.1)	71.7 (74.7) 301.3 (287.9)
ACTH-independent, n (%)	4 (13.3)	9 (28.1)
Plasma ACTH, pg/mL 24-h UFC, μg/d	5.9 (2.3) 66.9 (36.8)	10.0 (9.0) 142.2 (194.1)



ACTH, adrenocorticotropic hormone; BMI, body mass index; OL, open-label phase; RW, randomized withdrawal; SD, standard deviation; UFC, urinary free cortisol.

Randomized-withdrawal Results

HYPERTENSION



Primary Endpoint Met: Hypertension

Hypertension responders who randomized

- In the randomized-withdrawal phase, significantly more patients receiving placebo lost hypertension control compared to those who continued to receive relacorilant
 - Odds ratio 0.17 for relacorilant vs placebo (*P*=0.02)
 - Patients receiving relacorilant were **5.9x more likely to maintain hypertension response**



Loss of hypertension response

Similar Blood Pressure Trends Observed in all Patients Randomized, Favoring Relacorilant Over Placebo

In all patients with available ABPM data



ABPM, ambulatory blood pressure monitoring; DBP, diastolic blood pressure; ns, not significant (*P*≥0.05); RW, randomized withdrawal; SBP, systolic blood pressure. Blood pressure measured by ABPM. Error bars: Standard deviation. Wilcoxon rank sum test *P*-values for the observed mean within each treatment arm shown.

Similar Blood Pressure Trends Observed in all Patients Randomized, Favoring Relacorilant Over Placebo

In all patients with available ABPM data



ABPM, ambulatory blood pressure monitoring; DBP, diastolic blood pressure; ns, not significant (*P*≥0.05); RW, randomized withdrawal; SBP, systolic blood pressure. Blood pressure measured by ABPM; daytime blood pressure defined as blood pressure measurements between 6am and 10pm. Error bars: Standard deviation. Wilcoxon rank sum test *P*-values for the observed mean within each treatment arm shown.

Similar Blood Pressure Trends Observed in all Patients Randomized, Favoring Relacorilant Over Placebo

In all patients with available ABPM data



ABPM, ambulatory blood pressure monitoring; DBP, diastolic blood pressure; ns, not significant ($P \ge 0.05$); RW, randomized withdrawal; SBP, systolic blood pressure. Blood pressure measured by ABPM; nighttime blood pressure defined as blood pressure measurements between 10pm and 6am. Error bars: Standard deviation. Wilcoxon rank sum test *P*-values for the observed mean within each treatment arm shown.

Randomized-withdrawal Results

HYPERGLYCEMIA AND OTHER SYMPTOMS AND COMORBIDITIES

Improvements in Glycemic Measures Maintained With Relacorilant

	Relacorilant (n=30)	Placebo (n=32)	
Change from RW baseline to week RW12 in:			
AUC _{glucose} (in patients with hyperglycemia at study entry), h*mmol/L			
n	15	19	
Mean (SD)	+1.1 (4.7)	+4.9 (6.1)	
Wilcoxon signed rank sum P-value ^a	ns	0.0003	
HbA1c (in patients with hyperglycemia at study entry), %			
n	16	19	
Mean (SD)	+0.1 (0.8)	+0.3 (0.6)	
Wilcoxon signed rank sum P-value ^a	ns	0.03	
HbA1c (in patients with diabetes at study entry), %			
n	13	13	
Mean (SD)	+0.1 (0.8)	+0.4 (0.6)	
Wilcoxon signed rank sum P-value ^a	ns	0.04	

 At the end of the RW phase, patients who switched to placebo experienced significant increases in AUC_{alucose} and HbA1c

Randomized

Withdrawal

 In contrast, glycemic measures were maintained in patients who continued to receive relacorilant

AUC_{glucose}, glucose area under the curve; HbA1c, hemoglobin A1c; ns, not significant (*P*≥0.05); RW, randomized withdrawal. Wilcoxon rank sum test *P*-values for the observed mean within each treatment arm shown. ^aWilcoxon signed-rank test P-values within each treatment arm.

Improvements in Body Composition Maintained With Relacorilant

	Relacorilant (n=30)	Placebo (n=32)	
Change from RW baseline to week RW12 in all patients in the RW phase:			
Waist circumference			
n	26	30	
Mean (SD), cm	-1.2 (3.7)	+3.8 (10.4)	
Wilcoxon signed rank sum P-value ^a	ns	0.008	
Tissue fat mass			
n	17	22	
Mean (SD), %	-0.2 (1.7)	+1.6 (1.8)	
Wilcoxon signed rank sum P-value ^a	ns	0.0002	
Tissue lean mass			
n	17	22	
Mean (SD), %	+0.2 (1.7)	-1.6 (1.8)	
Wilcoxon signed rank sum P-value ^a	ns	0.0002	

Randomized

Withdrawal

- Similar trends observed across measures of body composition
- Those who switched to placebo experienced a deterioration in body composition
- In contrast, trends toward further improvement were observed in the relacorilant arm

BL, baseline; LSM, least squares mean; ns, not significant (P≥0.05); RW, randomized withdrawal; SE, standard error. Error bars: SE of the mean. ^aWilcoxon signed-rank test P-values within each treatment arm.

Randomized-withdrawal Results

SAFETY

Adverse Events Occurring in ≥5% of Patients

Among patients in the randomized-withdrawal phase

n (%)	Relacorilant (n=30)	Placebo (n=32)
Back pain	5 (16.7)	6 (18.8)
Headache	3 (10.0)	4 (12.5)
Arthralgia	3 (10.0)	3 (9.4)
Insomnia	0	4 (12.5)
Pain in extremity	2 (6.7)	2 (6.3)

Conclusions

- GRACE met its primary endpoint
- Significant improvements in hypertension, hyperglycemia, and other manifestations
 of cortisol excess were observed throughout the treatment with relacorilant
- Due to relacorilant's **specificity for the glucocorticoid receptor** and its **unique mechanism of action**, the observed efficacy was seen:
 - Without cases of relacorilant-induced irregular vaginal bleeding with endometrial hypertrophy
 - Without increases in cortisol concentrations and relacorilant-induced hypokalemia
 - Without reported cases of adrenal insufficiency
 - Without independently-confirmed QT prolongation

STUDY STUDY

Thanks to all Those who Contributed to the GRACE Study!

The GRACE investigators & their teams

- Dr. Lisa Abbott
- Dr. Amer Al-Karadsheh
- Dr. Carmen Aresta
- Prof. Dr. Giorgio Arnaldi
- Dr. Richard Auchus
- Prof. Corin Badiu
- Dr. Garni Barkhoudarian
- Prof. Isabelle Bourdeau
- Dr. Robert Busch
- Prof. Dr. Salvatore Cannavo
- Dr. Ty Carroll
- Asst. Prof. Dr. Catalin Buzdugă
- Prof. Dr. Iwona Chmiel-Perzynska
- Dr. Ulrich Dischinger
- Dr. Georgiana Dobri
- Dr. Diane Donegan
- Prof. Dr. Rivka Dresner Pollak

- Dr. Andjela Drincic
 - Dr. Honey East
 - Assoc. Prof. Dr. Atanaska Elenkova
 - Prof. Dr. Martin Fassnacht
 - Dr. Pouneh Fazeli
 - Dr. Richard A. Feelders
 - Dr. Rogelio Garcia Centeno
 - Dr. Eliza Geer
 - Dr. Hans Ghayee
 - Prof. Dr. Ezio Ghigo
 - Assoc. Prof. Dr. Aleksandra Gilis-Januszewska
 - Dr. Murray Gordon
 - Prof. Dr. Yona Greenman
 - Dr. Oksana Hamidi
 - Dr. Zeina Hannoush
 - Dr. Betul Hatipoglu
 - Dr. Anthony Heaney
 - Dr. Wenyu Huang
 - Dr. Syed Ali Imran
 - Prof. Dr. Andrea Isidori
 - Dr. Serge Jabbour
 - Dr. Daniel Katselnik

- Prof. Dr. Alexandra Kautzky-Willer
- Dr. Lawrence Kirschner
- Prof. Dr. Adam Kretowski
- Dr. Alice Levine
- Dr. Jonea Lim
- Dr. Joseph Mathews
- Dr. Harold Miller
- Dr. Le Min
- Dr. Dan Niculescu
- Dr. Jean Jacques Nya-Ngatchou
- Prof. Dr. Barbara
 Obermayer-Pietsch
- Dr. Jonathan Ownby
- Dr. John Parker
- Dr. Antonio Miguel Pico Alfonso
- Prof. Dr. Rosario Pivonello
- Dr. Cristina Preda
- Dr. Aurelian-Emil Ranetti
- Dr. Monica Recasens Sala
- Prof. Dr. Martin Reincke
- Dr. Leszek Romanowski

- Dr. Pnina Rotman-Pikielny
- Dr. Sergio Rovner
- Dr. Isaac Sachmechi
- Dr. Roberto Salvatori
- Dr. Susan Samson
- Prof. Carla Scaroni
- Dr. Susmeeta Sharma
- Prof. Dr. Ilan Shimon
- Dr. Julie Silverstein
- Dr. Alfonso Soto-Moreno
- Prof. Dr. Antonio Stigliano
- Prof. Dr. Massimo Terzolo
- Prof. Dr. Francisco Jose
 Tinahones Madueno
- Dr. Anke Tonjes
- Dr. Ehud Ur
- Dr. Elena Valassi
- Dr. Christina Wang
- Prof. Dr. Susan Webb
- Dr. Margaret Wierman
- Dr. Kevin Yuen

The study patients and their families.

The sponsor team

THANK YOU!