Laborphänomene und Laborfehler

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Endokrinologie /// Diabetologie /// Innere Medizin

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Vortragshonorare

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Boerhringer Ingelheim GmbH

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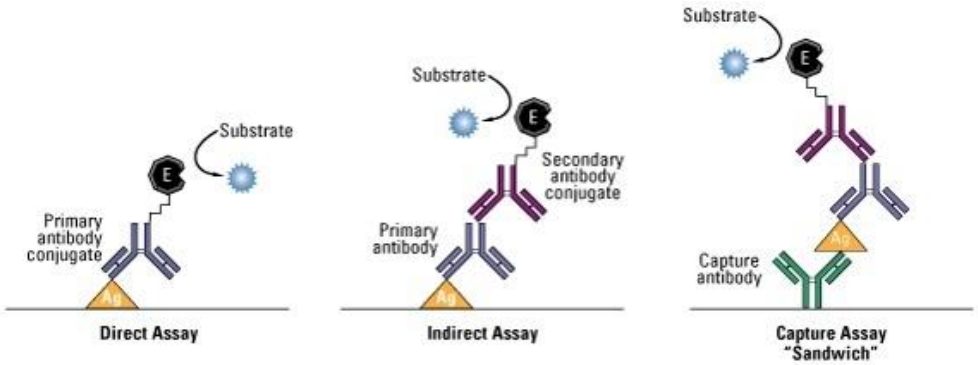
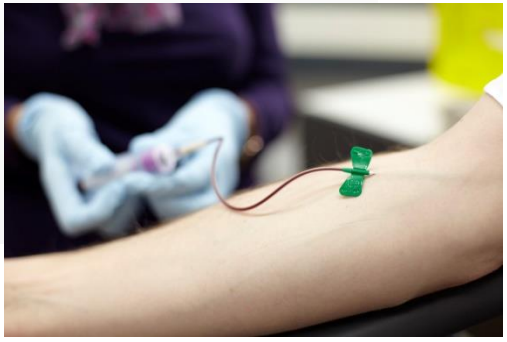
Interpretation

Parameter	Ergebnis		Referenzbereich
ACTH	1145 pg/ml	+	10.0 - 46.0
Cortisol	2,48 µg/dl	-	6.5 - 23.0 morgens
Androstendion	<0,3 ng/ml	-	0.3 - 3.3 bis 1,0 Postmenopause
DHEAS	<15 µg/dl		65 - 380
Nebennierenrinde Ak IFT	positiv .	+	negativ
Renin	>128 pg/ml	+	3,0 - 35
Aldosteron	29,52 pg/ml	-	40 - 310
Aldosteron / Renin Quotient	0,2306 .		<20

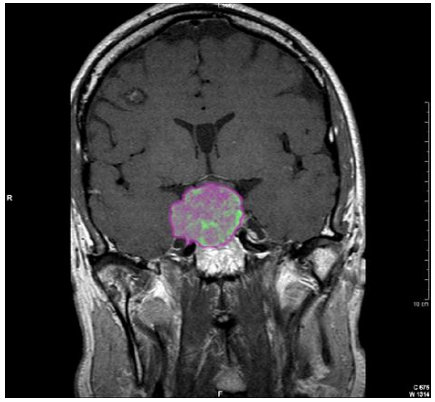
Analytische Interferenzen



Interpretations-Fehler (I)



Laborwerte ⟷ Bildgebung



w, 63 Jahre, cushingoid, Myopathie

Cortisol i.S. 8.00 ↑↑↑ 834nmol/l [180-640]

Chirurgie: OP-Indikation ?

Cortisol i.S. 24.00 ↑↑↑ 785nmol/l [50-140]
Urincortisol ↑↑↑ 1915 nmol/24Std. [55-500]
Dexamethason-Kurztest (2mg): 632 nmol/l [<80]

ACTH basal 42 pg/ml [17-52]
(CAVE präanalytische Kühlung)

Cortisol i.U. nach Dexa 4x2mg/die über 3 Tage
106 nmol/l [55-500]; Serum 705 nmol/l

<u>CRH-Test:</u>

Cortisol: 895 auf 1475 nmol/l

ACTH: 38 auf 68 pg/ml

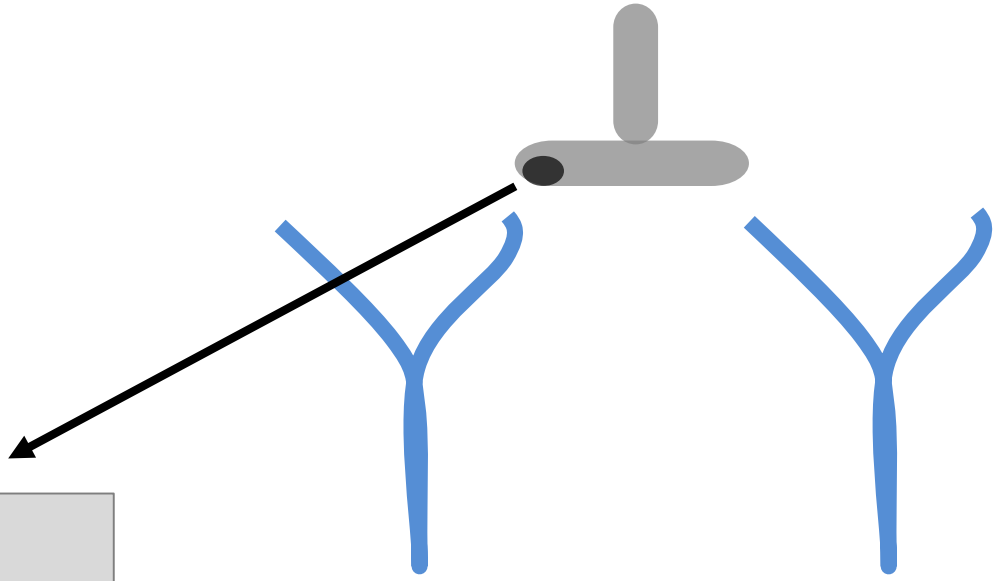
CT-Nebennierenadenom

DMW, 2001, 126, 232-234

Empty Sella

Sinus petrosus inferior

	rechts	**links**
ACTH basal	245 pg/ml	30 pg/ml
ACTH nach CRH	1349 pg/ml	136 pg/ml



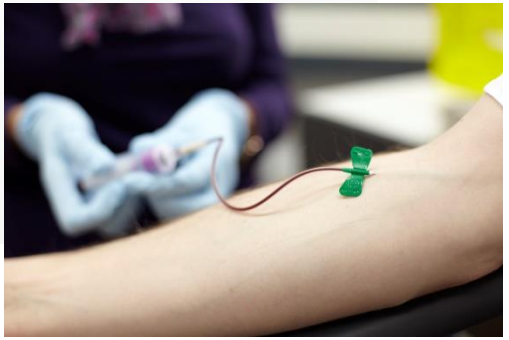
ACTH-produzierendes Hypophysenmikroadenom bei Morbus Cushing

V. femoralis

ACTH basal	33 pg/ml
ACTH nach CRH	72 pg/ml

DMW, 2001, 126, 232-234

Interpretations-Fehler (II)



Laborwert ⟷ **Nahrungsmittel-Interaktion**

Erhöhte freie Katecholamine nach Obst und Nüssen

Elevated Urinary Free and Deconjugated Catecholamines after Consumption of a Catecholamine-Rich Diet

8.30
two or three bananas (280 g of pulp), one quarter of a fresh pineapple (185 g of pulp), 50 g of shelled walnuts, and 140 ml of pineapple juice purchased at local commercial outlets.

10.30
280 ml of pineapple juice.



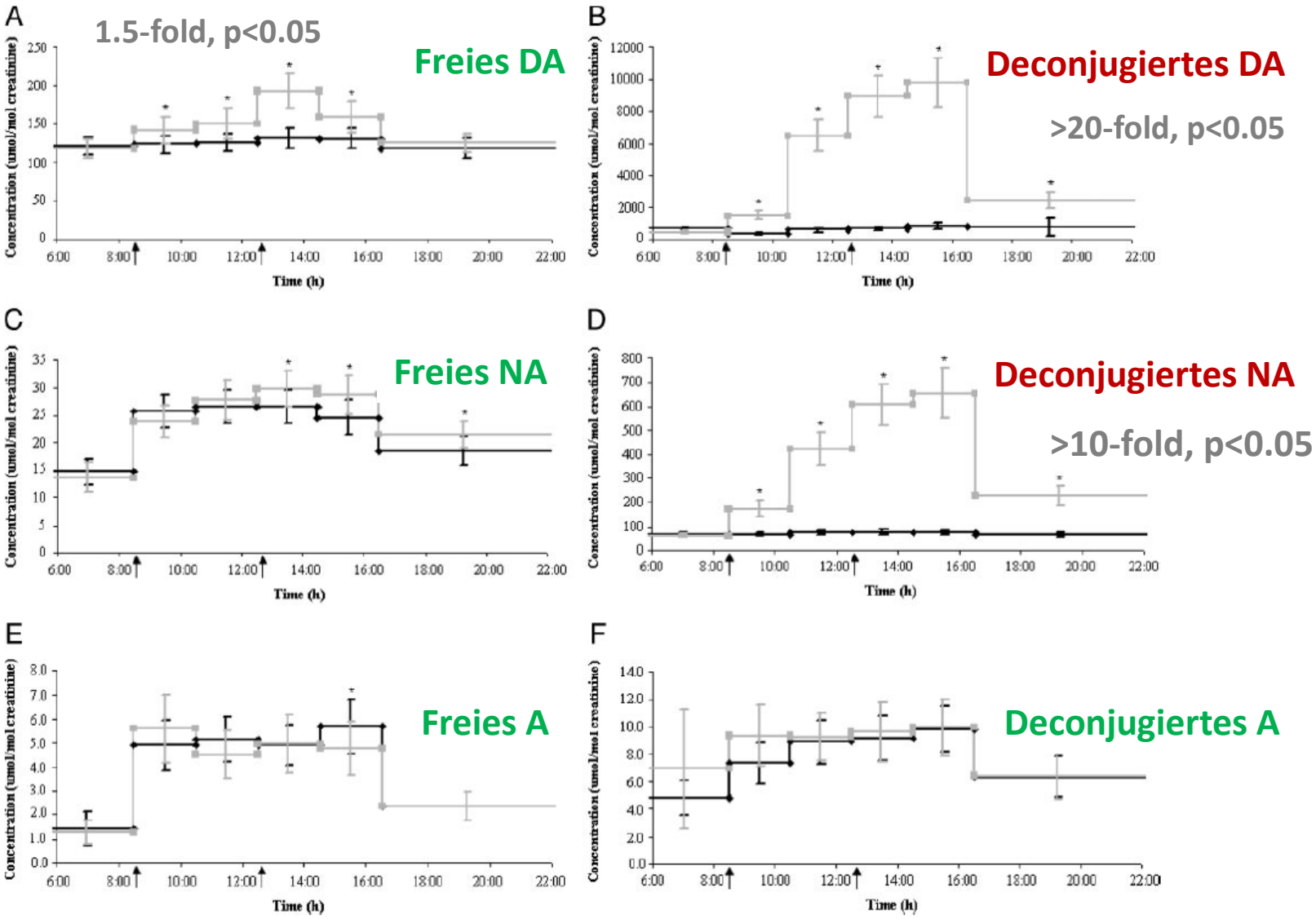
12.30
two or three bananas (280 g of pulp), one quarter of a fresh pineapple (185 g of pulp), 50 g of shelled walnuts, and 140 ml of pineapple juice purchased at local commercial outlets.

14.30
participants drank 280 ml of pineapple juice.

n=27
mass spectrometry measurements

De Jong et al., J Clin Endocrinol Metab, June 2010, 95(6):2851–2855

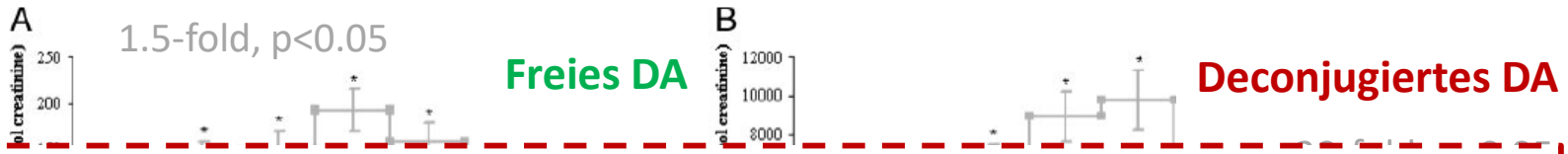
Elevated Urinary Free and Deconjugated Catecholamines after Consumption of a Catecholamine-Rich Diet



diet — control

De Jong et al., J Clin Endocrinol Metab, June 2010, 95(6):2851–2855

Elevated Urinary Free and Deconjugated Catecholamines after Consumption of a Catecholamine-Rich Diet



We therefore recommend ***repeated measurement*** of urinary free catecholamines to confirm the presence of an increased urinary catecholamine excretion.

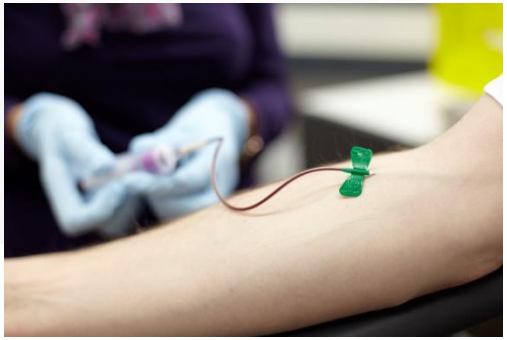
Dietary restrictions 24 h before this repeated sampling should be sufficient to circumvent increased levels by consumption of catecholamine-containing foods because this study showed that overnight catecholamine levels are returning to normal.

NA / A: HWZ 2-4min

diet — control

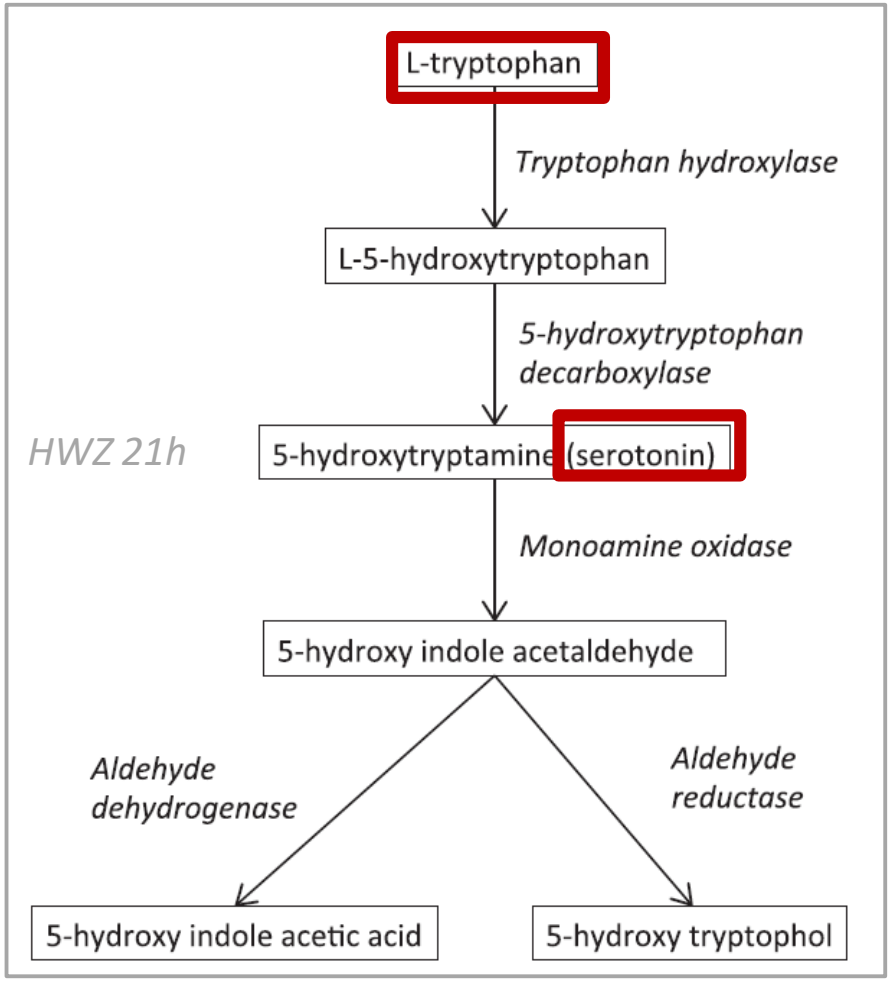
De Jong et al., J Clin Endocrinol Metab, June 2010, 95(6):2851–2855

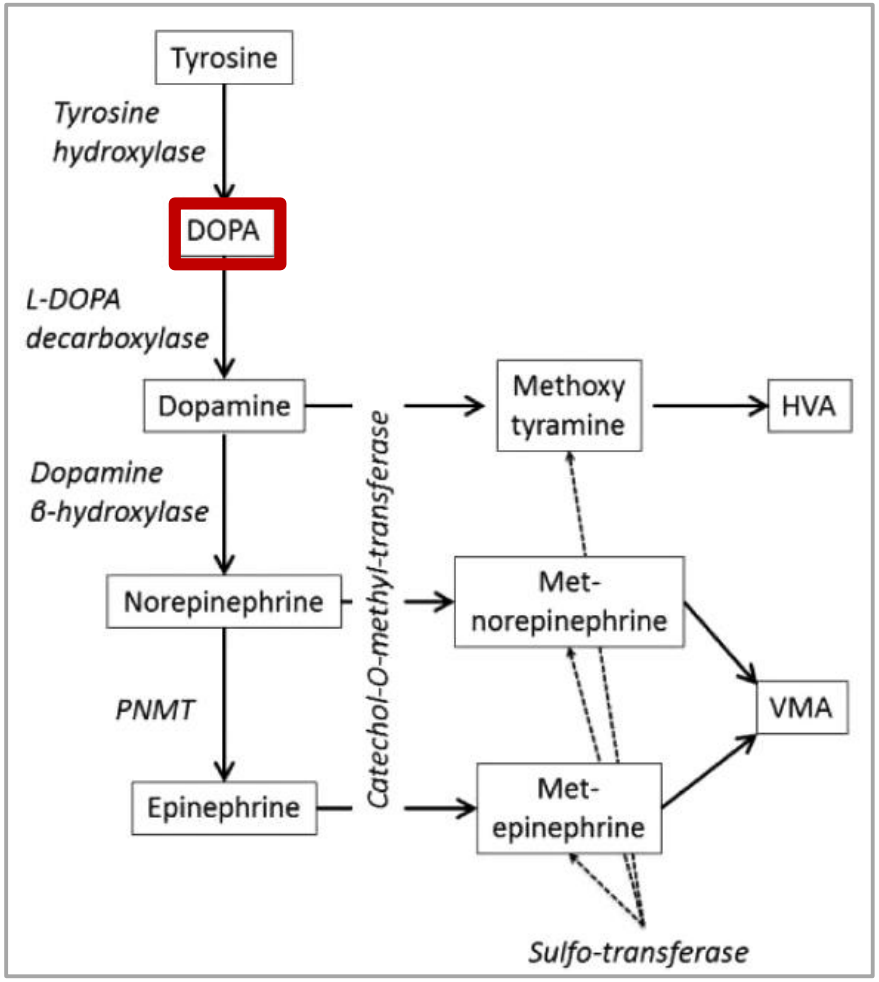
Interpretations-Fehler (III)



Laborwert ⇔ **Medikamenten-Interaktion**

Urinary sampling for 5HIAA and metanephrines determination: revisiting the recommendations





Corcuff et al., Endocr Connect 2017 Aug; 6(6): R87–R98.

Urinary sampling for 5HIAA and metanephrines determination: revisiting the recommendations

Analyte	Diet	Preservative	Drugs
5HIAA	Banana, plantain, pineapple, kiwi, plums, walnut, hickory nut Tryptophan-containing supplements	Yes (HCl)	Inhibitors of monoamine oxidase and of serotonin reuptake; serotonin receptor antagonist
Metanephrines	Banana, plantain nuts, tomatoes, beans	Not mandatory	Sympathomimetics, adrenergic receptor blockers, monamine oxidase inhibitors, noradrenaline uptake inhibitors, tricyclic antidepressants
VMA-HVA	Banana, plantain nuts, tomatoes, beans; Artificial vanilla flavour (VMA)	Yes (HCl)	Sympathomimetics, adrenergic receptor blockers, monamine oxidase inhibitors, noradrenaline uptake inhibitors, tricyclic antidepressants?

Corcuff et al., Endocr Connect 2017 Aug; 6(6): R87–R98.

Urinary sampling for 5HIAA and metanephrines determination: revisiting the recommendations

Analyte	Diet	Preservative	Drugs
5HIAA	Banana, plantain, pineapple, ... ory	Yes (HCl)	Inhibitors ... xidase and of se ... e; ...
Metanephrines		Not ... y	
VMA-HVA	Banana, ... ntain nuts, tomato ... beans; Artificial vanilla ... our (VMA)	Yes (HCl)	... ers, m ... ors ... aline u ... ic antidepressa...

Avoid

48 h

24 h

Corcuff et al., Endocr Connect 2017 Aug; 6(6): R87–R98.

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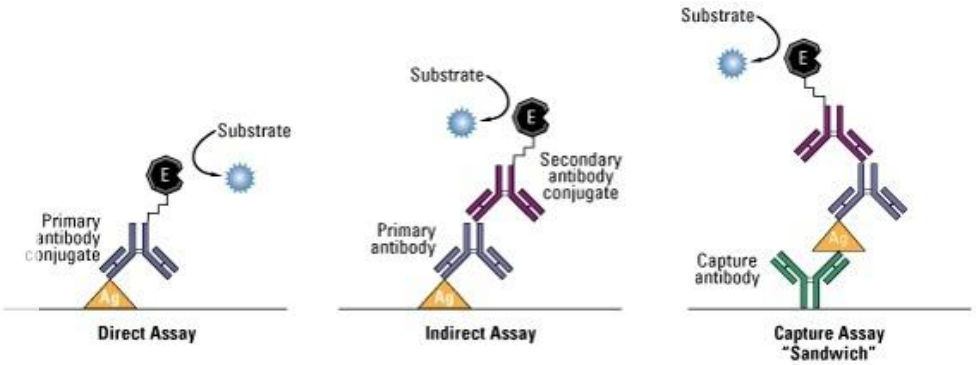
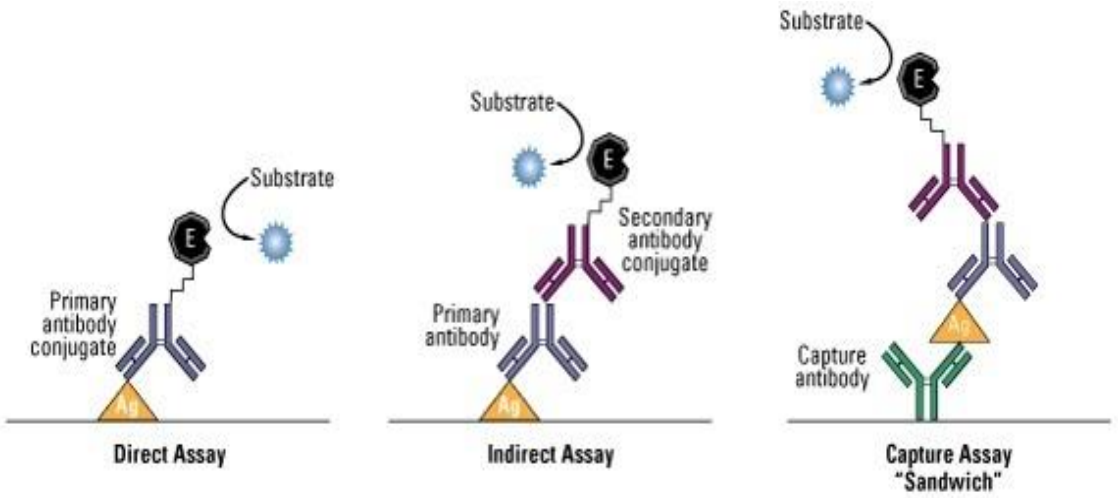
Analytische Interferenzen



Paracetamol (Acetaminophen) interagiert mit Assays

Urinary sampling for 5HIAA and metanephrines determination: revisiting the recommendations

Analyte		Analytical interferences*
5HIAA		Paracetamol (Acetaminophen)
Metanephrines		Paracetamol, methenamine, urapidil, amoxicillin, buspirone, mesalamine sulphasalazine
VMA-HVA		Paracetamol

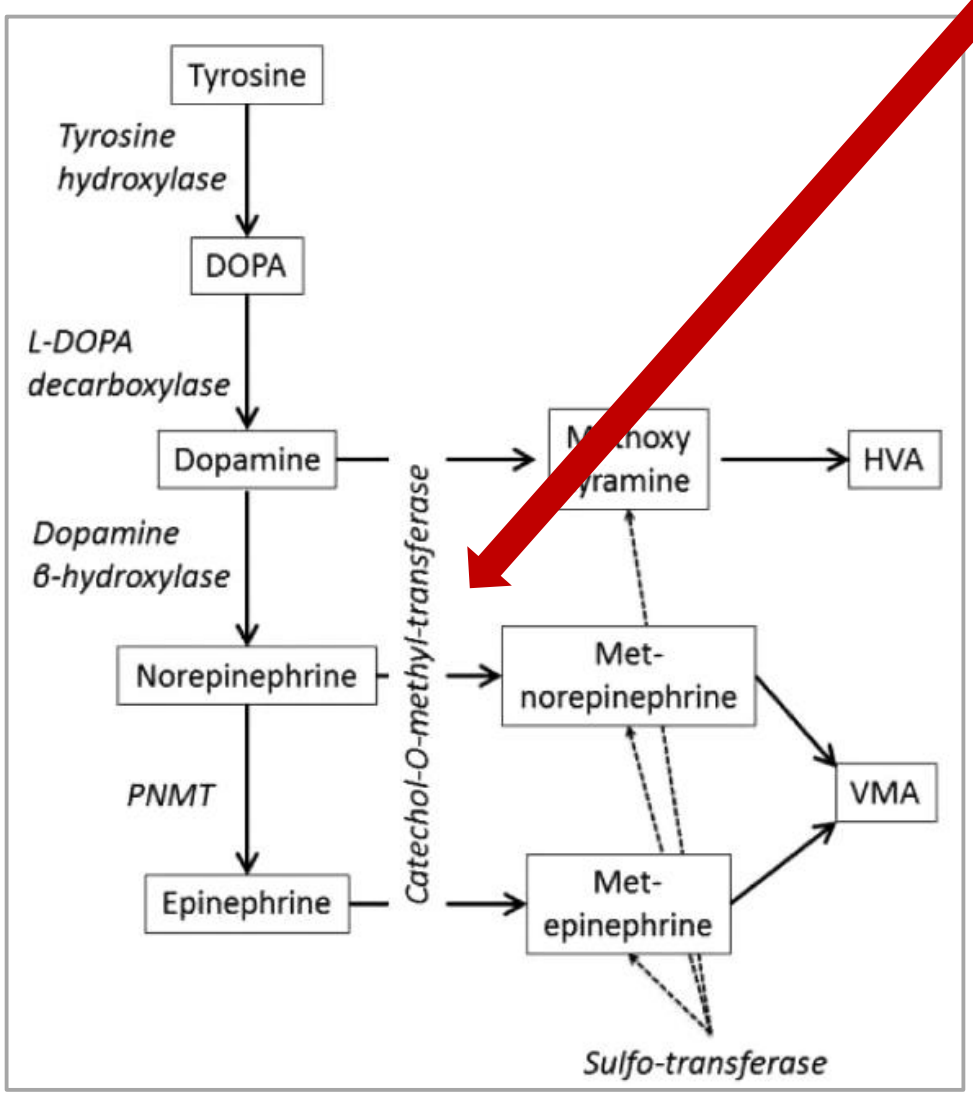


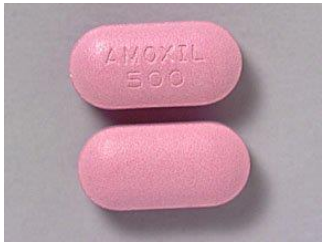
hemmt den Abbau von Tryptophan (Tryptophan-Hydrolase) und senkt 5-HIES „falsch niedrige Werte“

Elektrochemische Interferenz mit amperometrischen Biosensoren „falsch niedrige Werte“

Corcuff et al., Endocr Connect 2017 Aug; 6(6): R87–R98.

Alkohol und Amoxicillin hemmt COMT





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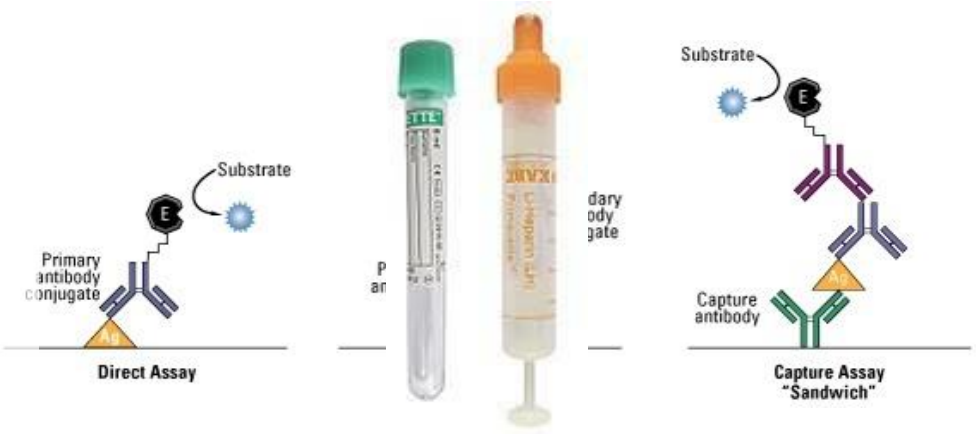
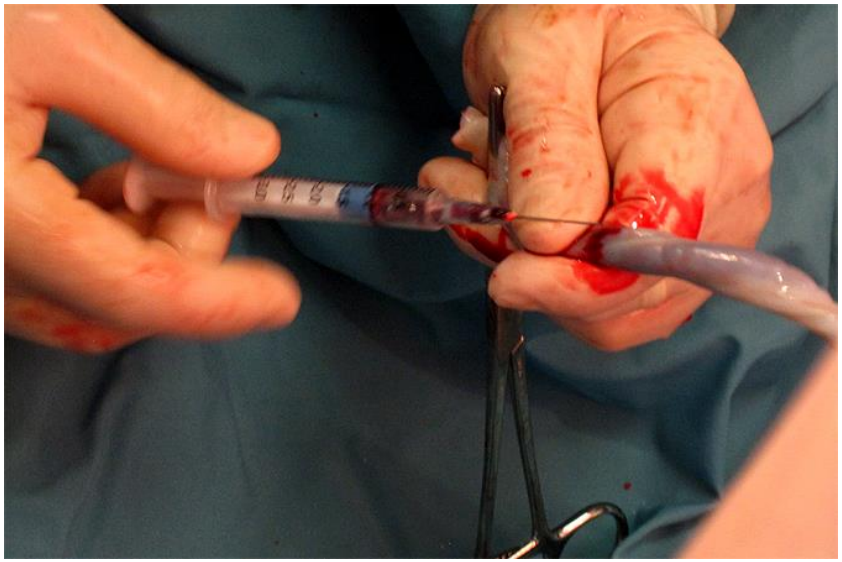


Neonatale Hyperthyreose durch unbehandelte Mutter mit Morbus Basedow (TRAK 56 U/l; Norm <2)

Bisschop et al., NEJM March 2014; 370, No 13, 1237

Falsch-positve TSH-Receptor-Ak (TRAK)



Mütter mit Morbus Basedow

Neugeboren-TRAK ???

lithium-heparin

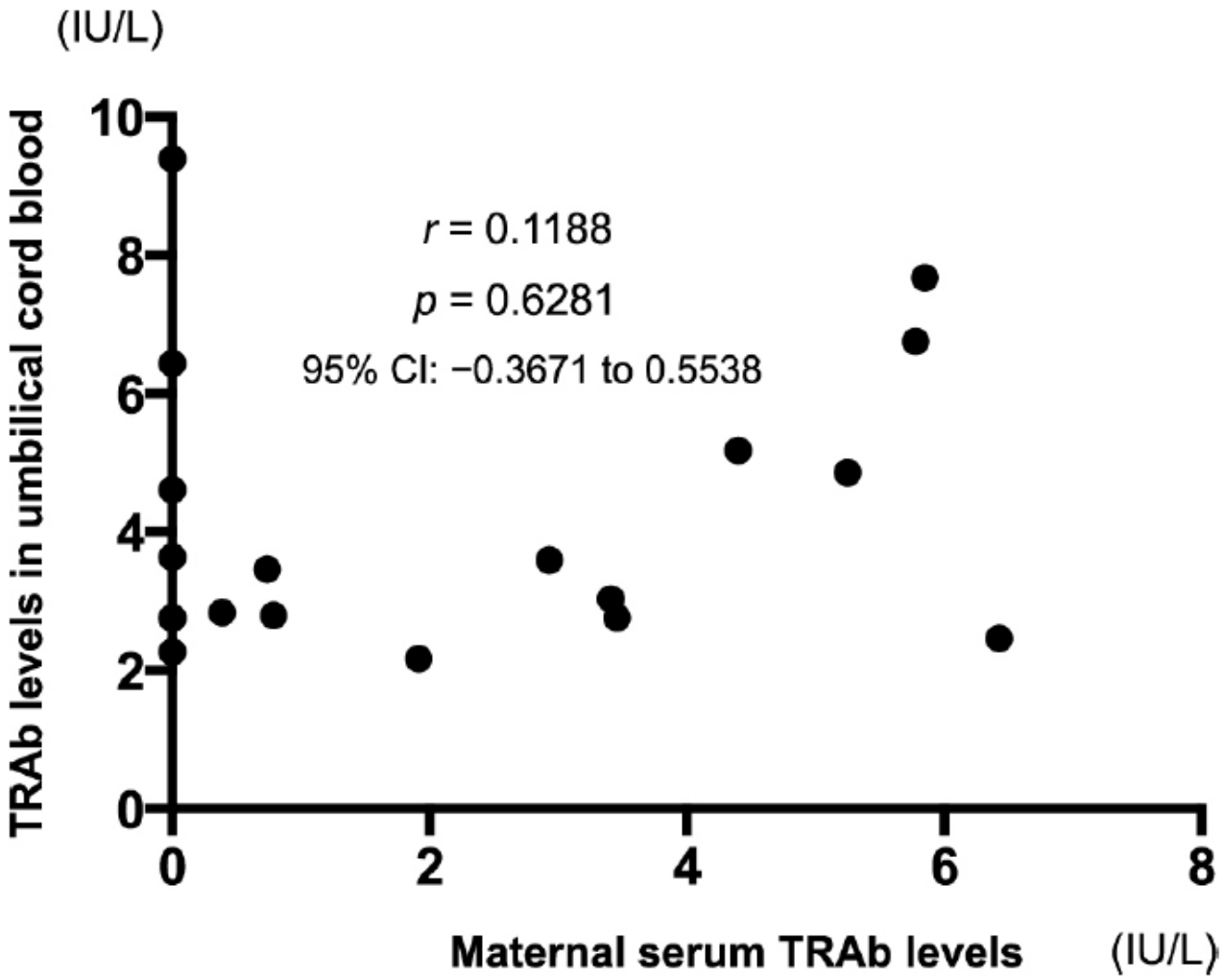
serum

Wada et al., …. Hashimoto. Jan. 30, 2018, Endocrine Journal

#	Mothers					Neonates							
	TSH (μU/mL)	FT3 (pg/mL)	FT4 (ng/dL)	TRAb (IU/L)	ATD	Gestational age (week)	Birth weight (g)	Sex	TSH (μU/mL)	FT3 (pg/mL)	FT4 (ng/dL)	TRAb (lithium-**Heparin** plasma) (IU/L)	TRAb **Serum** (IU/L)
1	1.68	2.55	1.11	UD	–	40	3,872	M	8.32	N/A	1.30	4.61	UD
2	N/A	N/A	N/A	UD	+	37	3,108	F	9.60	1.50	1.10	3.31	0.35
3	1.25	2.00	0.90	3.46	–	40	2,764	F	6.27	N/A	1.30	2.76	UD
4	0.49	2.20	1.00	0.39	–	37	2,104	M	12.07	1.70	1.20	2.84	UD
5	<0.01	5.30	2.00	5.85	+	40	3,112	M	2.45	1.30	1.40	3.11	UD
6	<0.01	4.02	1.35	0.74	+	39	4,002	M	1.34	1.65	1.17	3.46	0.58

Wada et al., …. Hashimoto. Jan. 30, 2018, Endocrine Journal

Correlation between maternal serum TRAb levels and those in umbilical cord blood



Wada et al., …. Hashimoto. Jan. 30, 2018, Endocrine Journal

Falsch-positive TSH-Rezeptor-Ak (TRAK)

— Neugeborene von euthyreoten Müttern —

Table 2 Nine neonates born to euthyroid mothers

Heparin-Plasma	Plasma
TRAb (lithium-heparin plasma) (IU/L)	TRAb (sodium-heparin plasma) (IU/L)
1.39	1.16
1.15	1.03
1.98	1.88
2.06	1.78
2.63	**2.37**
2.06	**2.05**
1.52	1.10
0.95	0.37
1.90	1.55

Wada et al., …. Hashimoto. Jan. 30, 2018, Endocrine Journal

Falsch-positive TSH-Rezeptor-Ak (TRAK)

— Neugeborene von euthyreoten Müttern —

Table 2 Nine neonates born to euthyroid mothers

	Serum				Heparin-Plasma	Plasma
#	TSH (μU/mL)	FT3 (pg/mL)	FT4 (ng/dL)	TRAb (IU/L)	TRAb (lithium-heparin plasma) (IU/L)	TRAb (sodium-heparin plasma) (IU/L)
1	4.68	UD	1.00	UD	1.39	1.16
2	3.27	1.30	1.07	UD	1.15	1.03
3	6.40	1.35	1.28	UD	1.98	1.88
4	7.20	1.35	1.13	UD	**2.06**	1.78
5	6.26	1.71	1.13	UD	**2.63**	**2.37**
6	3.96	1.17	1.27	UD	**2.06**	**2.05**
7	22.61	1.07	1.13	UD	1.52	1.10
8	5.52	1.05	1.09	UD	0.95	0.37
9	11.24	1.53	1.20	UD	1.90	1.55

Wada et al., …. Hashimoto. Jan. 30, 2018, Endocrine Journal

Falsch-positive TSH-Rezeptor-Ak (TRAK)

— Graves' disease (#1–3) and **adult-healthy** volunteers (#4–7)—

Table 3 Serum and lithium- and sodium-heparin plasma TRAb levels of adult patients with Graves' disease (#1–3) and adult-healthy volunteers (#4–7)

						serum	Lithium heparin		
#	Age (years old)	Sex	TSH (μU/mL)	FT3 (pg/mL)	FT4 (ng/dL)	TRAb (serum) (IU/L)	TRAb (lithium-heparin plasma) (IU/L)	TRAb (sodium-heparin plasma) (IU/L)	TRAb (lithium-heparin plasma) (second-generation) (IU/L)
1	22	F	UD	32.7	7.78	58.19	71.86	57.86	N/A
2	28	F	3.61	2.51	0.92	2.78	5.62	5.71	N/A
3	25	M	UD	5.64	1.88	23.46	26.69	26.93	N/A
4	32	M	0.92	3.11	1.02	UD	2.37	1.93	UD
5	26	F	1.49	3.20	1.15	UD	2.86	0.30	UD
6	40	M	1.06	2.72	0.86	UD	2.70	UD	UD
7	40	F	1.48	2.43	0.99	UD	2.77	3.06	UD

Wada et al., …. Hashimoto. Jan. 30, 2018, Endocrine Journal

Interpretation

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ACTH	1145 pg/ml	+	10.0 - 46.0
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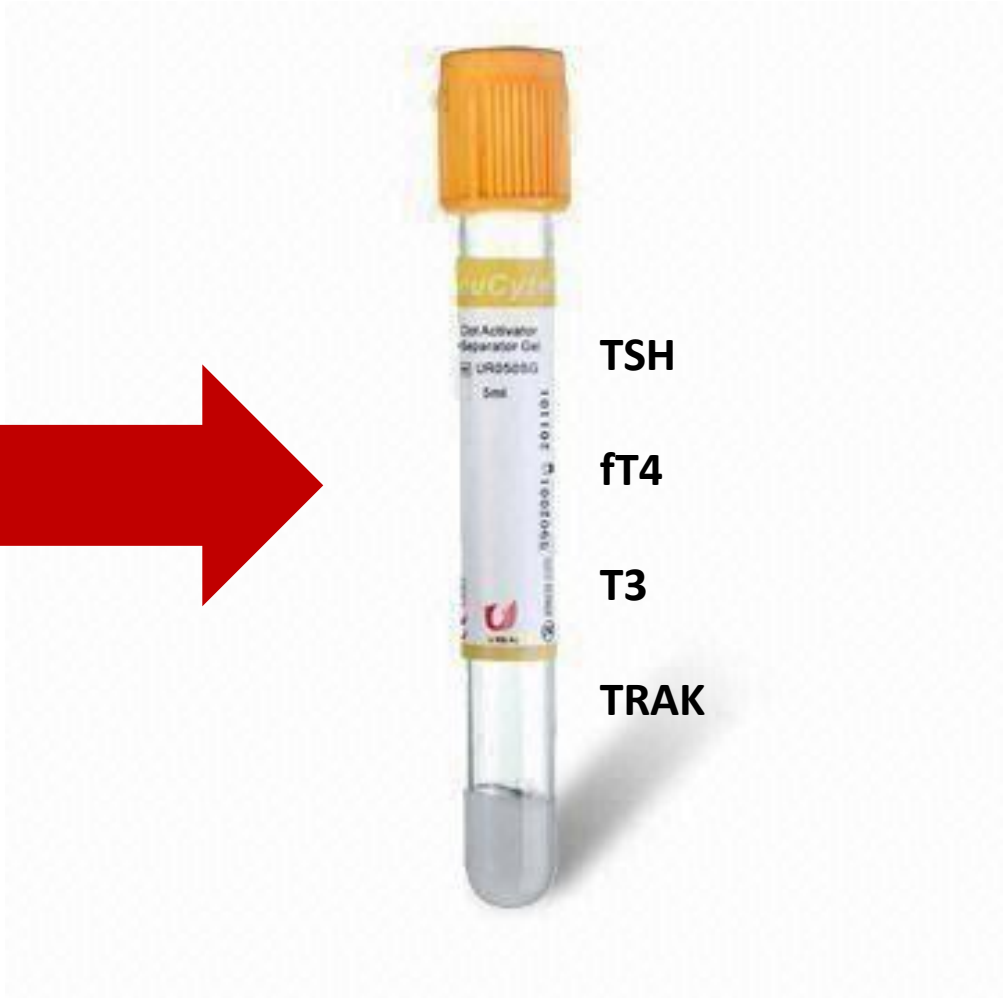
Analytische Interferenzen



TSH

fT4

T3

TRAK

Table 1. Characteristics of Six Children with Biotin-Induced Laboratory Indications of Autoimmune Hyperthyroidism.*

Variable	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
Sex	Female	Female	Male	Male	Male	Male
Age	9 yr	2 yr	2 yr	5 mo	1 mo	1 mo
Primary disease	BTBGD	BTBGD	BTBGD	Infantile mitochondrial disease	Neonatal mitochondrial disease	Neonatal mitochondrial disease
Biotin dose (mg/kg/day)	10	14	15	2	7	8
Concomitant medication	Thiamine	Thiamine, methimazole, cholecalciferol, levetiracetam, chloral hydrate	Thiamine, methimazole, oxcarbazepine	Thiamine, sodium phenylbutyrate, propranolol, nystatin, cholecalciferol	CoQ10, thiamine, cholecalciferol, carnitine, riboflavin, bisoprolol, aspirin, furosemide	CoQ10, thiamine, methimazole, cholecalciferol, carnitine, riboflavin

6 Kinder mit Biotin-Induzierter hyperthyreoter Laboranalytik

* Serum biotin levels were highly elevated in all children during therapy (>3000 ng per liter). Levels of free thyroxine (T_4), total triiodothyronine (T_3), and thyrotropin were normalized within 24 to 48 hours after the discontinuation of biotin in all patients, whereas normalization of levels of anti–thyrotropin receptor antibodies took up to several days in some patients. Normal ranges are as follows: thyrotropin, 0.85 to 6.46 μIU per milliliter; free T_4, 0.94 to 1.71 ng per deciliter; anti–thyrotropin receptor antibodies, less than 1.7 IU per liter; and total T_3, 0.8 to 2.6 ng per deciliter. BTBGD denotes biotin–thiamine–responsive basal ganglia disease, CoQ10 coenzyme Q10, and ND not determined.

† After the discontinuation of biotin, mild hypothyroidism became evident, with spontaneous recovery after the discontinuation of methimazole. Possible long-term complications due to transient hypothyroidism are unclear in this patient.

‡ Methimazole treatment intermittently normalized laboratory values during biotin treatment. After the discontinuation of biotin and methimazole, all values normalized completely. There was no evidence of long-term complications due to transient hypothyroidism.

N Engl J Med 2016; 375:704-706

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Sex	Female	Female	Male	Male	Male	Male
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Concomitant medication	Thiamine	Thiamine, methimazole, cholecalciferol, levetiracetam, chloral hydrate	Thiamine, methimazole, oxcarbazepine	Thiamine, sodium phenylbutyrate, propranolol, nystatin, cholecalciferol	CoQ10, thiamine, cholecalciferol, carnitine, riboflavin, bisoprolol, aspirin, furosemide	CoQ10, thiamine, methimazole, cholecalciferol, carnitine, riboflavin
Laboratory results						
During biotin treatment						
Thyrotropin (μIU/ml)	0.05	0.02	0.04	0.02	0.08	0.03
Free T_4 (ng/dl)	6.24	>7.77	>7.77	>7.77	>7.77	>7.77
Anti–thyrotropin receptor antibodies (IU/liter)	38.6	>40.0	>40.0	>40.0	>40.0	>40.0
Total T_3 (ng/dl)	>6.5	ND	>6.5	>6.5	>6.5	ND

* Serum biotin levels were highly elevated in all children during therapy (>3000 ng per liter). Levels of free thyroxine (T_4), total triiodothyronine (T_3), and thyrotropin were normalized within 24 to 48 hours after the discontinuation of biotin in all patients, whereas normalization of levels of anti–thyrotropin receptor antibodies took up to several days in some patients. Normal ranges are as follows: thyrotropin, 0.85 to 6.46 μIU per milliliter; free T_4, 0.94 to 1.71 ng per deciliter; anti–thyrotropin receptor antibodies, less than 1.7 IU per liter; and total T_3, 0.8 to 2.6 ng per deciliter. BTBGD denotes biotin–thiamine–responsive basal ganglia disease, CoQ10 coenzyme Q10, and ND not determined.

† After the discontinuation of biotin, mild hypothyroidism became evident, with spontaneous recovery after the discontinuation of methimazole. Possible long-term complications due to transient hypothyroidism are unclear in this patient.

‡ Methimazole treatment intermittently normalized laboratory values during biotin treatment. After the discontinuation of biotin and methimazole, all values normalized completely. There was no evidence of long-term complications due to transient hypothyroidism.

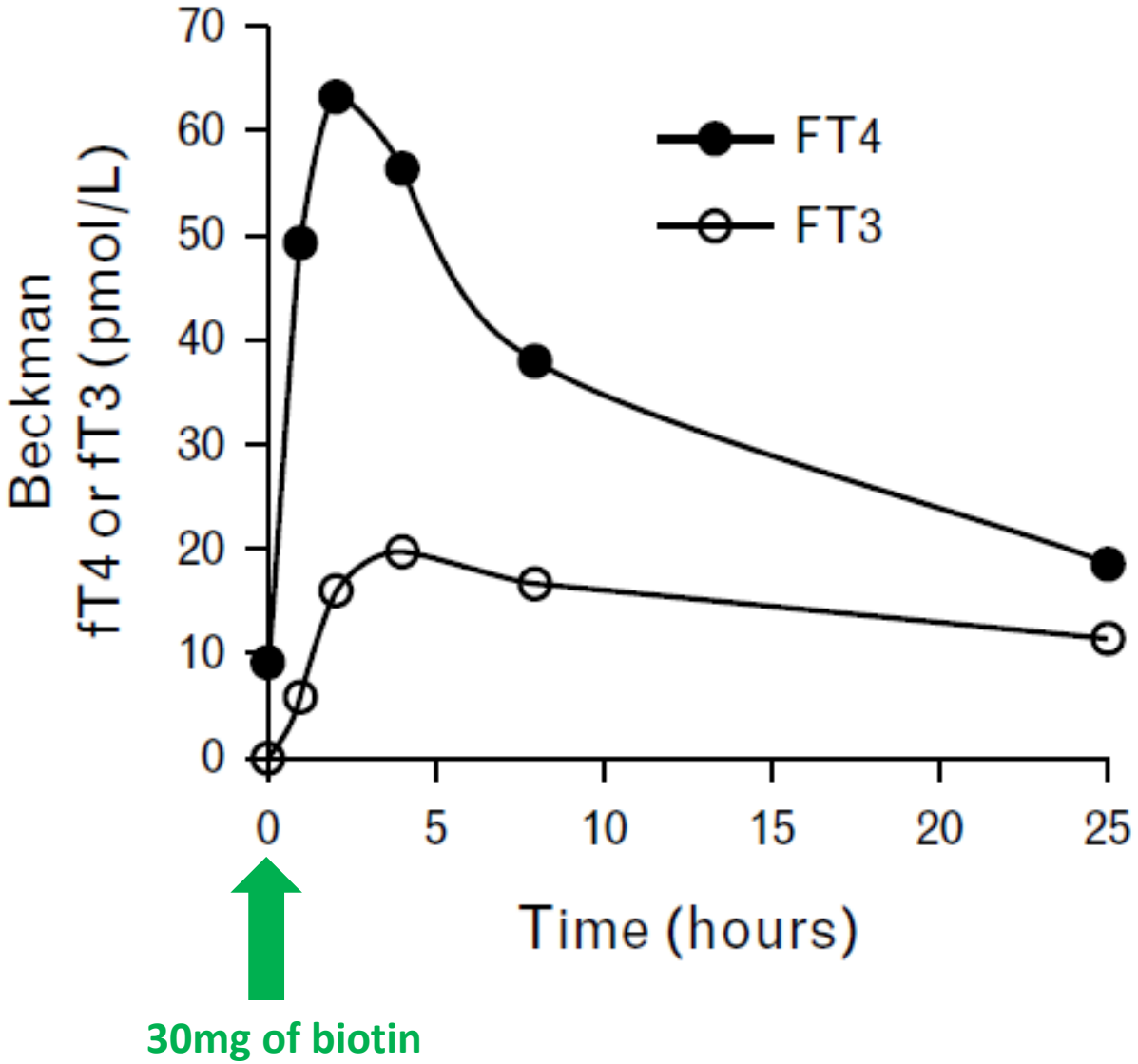
Table 1. Characteristics of Six Children with Biotin-Induced Laboratory Indications of Autoimmune Hyperthyroidism.*

Variable	Patient 1	Patient 2	Patient 3	Patient 4	Patient 5	Patient 6
Sex	Female	Female	Male	Male	Male	Male
Age	9 yr	2 yr	2 yr	5 mo	1 mo	1 mo
Primary disease	BTBGD	BTBGD	BTBGD	Infantile mitochondrial disease	Neonatal mitochondrial disease	Neonatal mitochondrial disease
Biotin dose (mg/kg/day)	10	14	15	2	7	8
Concomitant medication	Thiamine	Thiamine, methimazole, cholecalciferol, levetiracetam, chloral hydrate	Thiamine, methimazole, oxcarbazepine	Thiamine, sodium phenylbutyrate, propranolol, nystatin, cholecalciferol	CoQ10, thiamine, cholecalciferol, carnitine, riboflavin, bisoprolol, aspirin, furosemide	CoQ10, thiamine, methimazole, cholecalciferol, carnitine, riboflavin
Laboratory results						
During biotin treatment						
Thyrotropin (μIU/ml)	0.05	0.02	0.04	0.02	0.08	0.03
Free T_4 (ng/dl)	6.24	>7.77	>7.77	>7.77	>7.77	>7.77
Anti–thyrotropin receptor antibodies (IU/liter)	38.6	>40.0	>40.0	>40.0	>40.0	>40.0
Total T_3 (ng/dl)	>6.5	ND	>6.5	>6.5	>6.5	ND
1–7 Days after discontinuation of biotin						
Thyrotropin (μIU/ml)	1.80	3.75	6.07	2.20	8.12	2.87
Free T_4 (ng/dl)	1.58	1.70	1.16	1.13	1.84	1.91
Anti–thyrotropin receptor antibodies (IU/liter)	<0.3	ND	0.7	1.0	0.4	<0.3
Total T_3 (ng/dl)	2.0	ND	1.8	ND	1.8	2.3
Antithyroid medication	No	Methimazole treatment for 14 mo with up to 1.9 mg/kg/day†	Methimazole treatment for 3.5 mo with up to 0.9 mg/kg/day‡	No	No	Methimazole treatment for 2 wk

(T_3), and thyrotropin were normalized
took up to several days in some patients.
dies, less than 1.7 IU per liter; and total T_3,
. Possible long-term complications due to
ole, all values normalized completely.

The results were falsely increased or decreased according to whether a competitive method of measurement (for free T_4 and total T_3) or noncompetitive method (for thyrotropin) was used.

Interference of the Ingested Biotin on fT4 and fT3



Wijeratne NG et al., Pathology · October 2012

W, 33 Jahre, müde, Gewichtsverlust, Schwitzen, 8 Wochen postpartum

Table 1. Results of Hormonal Assays From Different Analytical Platforms[a]

	Architect C8000, Abbott (CLIA)	Advia Centaur XP, Siemens (CLIA)	Dxl, Beckman Coulter (CLIA)	Cobas, Roche Diagnostics (ECLIA)
PRL, ng/mL	246 (5.2–26.5)	2.3 (2.8–29.2)	105 (3.3–26.7)	32.1 (4.8–23.3)
TSH, μIU/mL	259 (0.35–4.94)	70 (0.35–5.50)	13.4 (0.34–5.60)	1.88 (0.27–4.20)
FSH, IU/L	>150 (3.03–8.08)	26 (1.5–33.4)	125 (1.79–22.51)	3.35 (3.5–12.5)
β-hCG, μIU/mL	2908 (0–5)	67 (0–5)	255 (<0.5)	0.1 (0–5)
iPTH, pg/mL	566 (15–68.3)	180 (14–72)	44 (12–88)	43.8 (15–65)
ACTH, pg/mL	>1500 (4.7–48.8)	17.2 (5–45)	NA	19.8 (7.2–63.3)

Numbers in parentheses indicate normal reference range for assayed hormone on corresponding platform.

Abbreviations: iPTH, intact PTH; NA, not applicable.

[a] Calcitonin, IGF-1, and RF were not included in the different platforms analysis because they can only be assayed in specific platforms.

J Clin Endocrinol Metab 100: 2147–2153, 2015

Verdünnungsreihe – New Tubes - PEG

Table 2. Results of Serial Dilutions of the Sample

	Without Dilution	1/2 Dilution	1/4 Dilution	1/8 Dilution
PRL (5.2–26.5), ng/mL	246	>400	474	412
TSH (0.35–4.94), μIU/mL	259	204	237	260
FSH (3.03–8.08), IU/L	>150	248	255	300
β-hCG (0–5), μIU/mL	2908	2650	1485	1008
iPTH (15–68.3), pg/mL	566	506	441	512
ACTH (4.7–48.8), pg/mL	>1500	392	165	144

Table 3. Results Before and After Incubation in Heterophile Antibody Blocking Tubes

	Before	After
PRL (5.2–26.5), ng/mL	228.1	22.04
TSH (0.35–4.94), μIU/mL	>100	1.736
FSH (3.03–8.08), IU/L	>150	3.39
β-hCG (0–5), μIU/mL	3219	<1.2
iPTH (15–68.3), pg/mL	601.6	81.3
ACTH (4.7–48.8), pg/mL	>1500	7.66
IGF-1 (130–354), ng/mL	1864	244
RF (0–20), U/mL	188	<20
Calcitonin (0–11.5), pg/mL	270	<2

Numbers in parentheses indicate normal reference range for assayed hormone.

Abbreviation: iPTH, intact PTH.

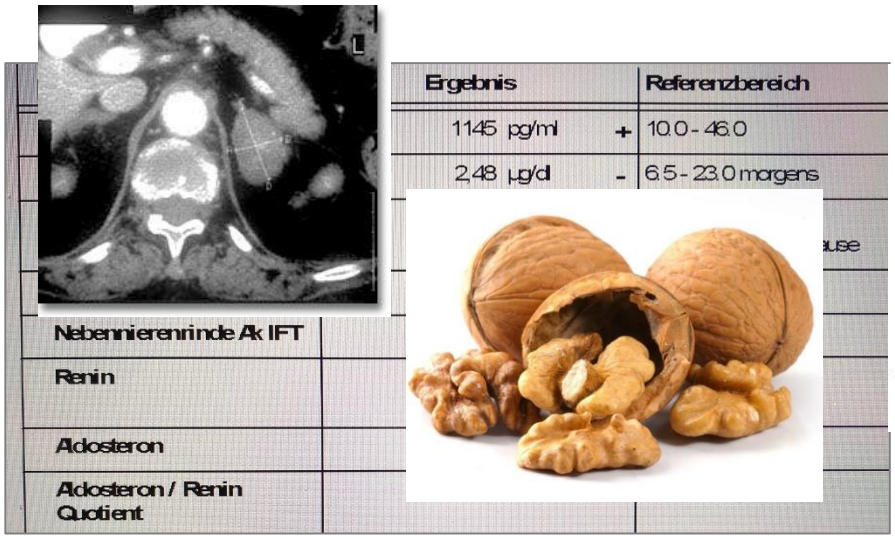
Inkubation mit Heterophilen-Ak-Blockierenden Tubes

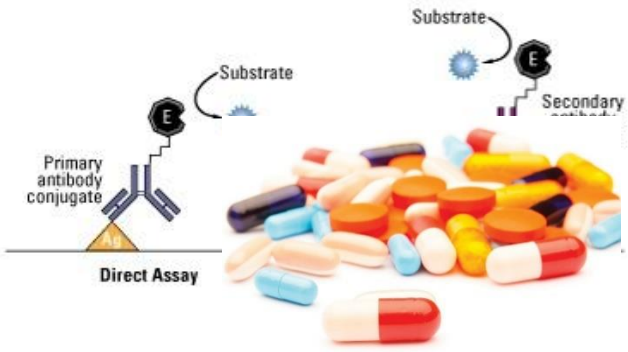
The post-polyethylene glycol (PEG) recovery resulted in hormone levels in the normal range.

J Clin Endocrinol Metab 100: 2147–2153, 2015

Interpretation

Analytische Interferenzen





Corcuff et al., Endocr Connect 2017 Aug; 6(6): R87–R98.

Laborphänomene und Laborfehler

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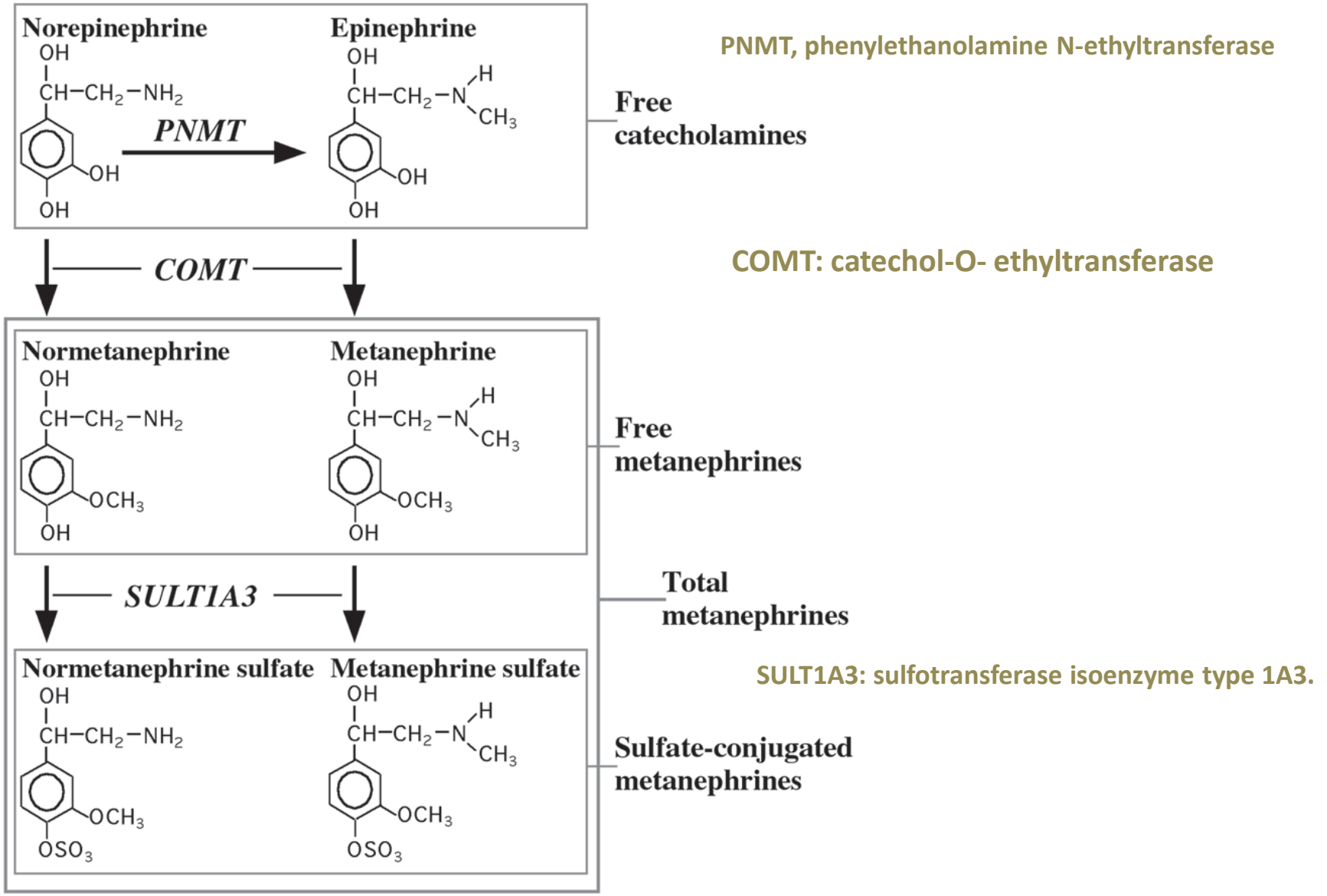
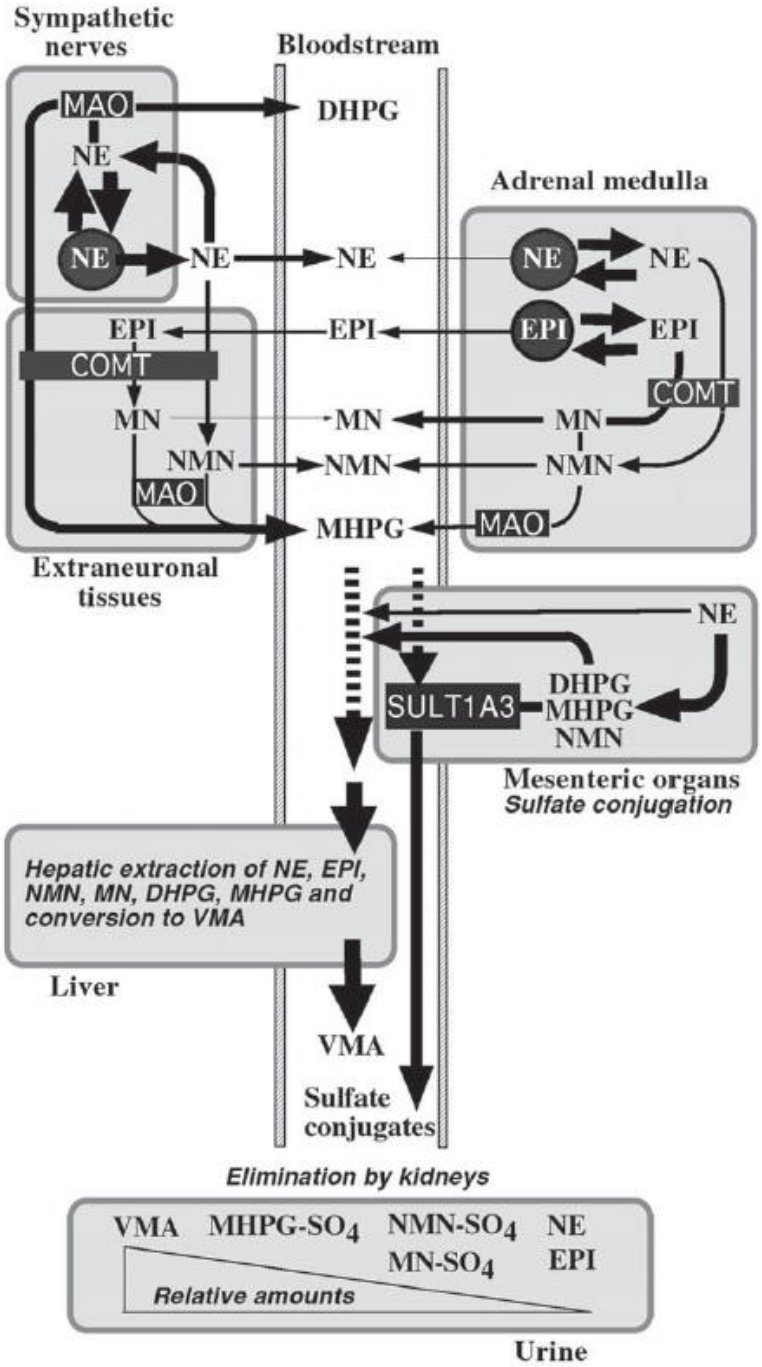
The main fraction of catecholamines is converted to sulfate conjugates by a sulfotransferase isoenzyme (SULT1A3), located in the gastrointestinal tract, that inactivates both endogenous and dietary-derived (exogenous) catecholamines (10, 11). Therefore, catecholamine outputs can be presented as free or deconjugated (sum of free and sulfate-conjugated) concentrations.





Review

Pheochromocytoma:
Rediscovery as a Catecholamine-Metabolizing Tumor

Graeme Eisenhofer, PHD, **David S. Goldstein,** MD, PHD, **Irwin J. Kopin,** MD, **and J. Richard Crout,** MD

Article *in* Endocrine Pathology · February 2003
DOI: 10.1007/s12022-003-0012-4 · Source: PubMed

Fig. 4. Model showing the contribution of the adrenal medulla in relation to other organs and tissues to production of circulating catecholamines and catecholamine metabolites. Abbreviations: MAO, monoamine oxidase; COMT, catechol-O-methyltransferase; SULT1A3, sulfotransferase type 1A3; NE, norepinephrine; EPI, epinephrine; NMN, normetanephrine; MN, metanephrine; DHPG, 3,4-dihydroxyphenylglycol; MHPG, 3-methoxy-4-hydroxyphenylglycol; VMA, vanillylmandelic acid; NMN-SO_4, normetanephrine sulfate; MN-SO4, metanephrine sulfate; MHPG-SO_4, 3-methoxy-4-hydroxyphenylglycol sulfate.

Paracetamol has been the origin of one of the most serious electrochemical interferences when using oxidase-based amperometric biosensors. It produced an interfering current that increased glucose readings in early glucose sensors (66). In fact, *Paracetamol* can be assayed by electrochemical detection (67). Thus, it has been described as a potential source of interference in electrochemical detection after HPLC separation of analytes such as 5HIAA, metanephrines and catecholamines (68) or vanilmandelic and homovanillic acids (69) or serotonin (70) depending on the analytical method used (mobile phase, column, etc.). It could interfere with the peak of internal standard leading to overestimation of its value and, thus, lowering the value of the 5HIAA in the sample. Quality control of the internal standard signal should prevent this error. Of note, *Paracetamol* could, at least in rats, inhibit an enzyme metabolising tryptophan thereby reducing urinary 5HIAA (71).

The results were falsely increased or decreased according to whether a competitive method of measurement (for free T_4 and total T_3) or noncompetitive method (for thyrotropin) was used.

N Engl J Med 2016; 375:704-706