Hypertension, Hyperlipidemia, and GLP-1 agonists After Transplantation

Maddy Morrison, PharmD BCTXP
Vanderbilt University Medical Center

Objectives

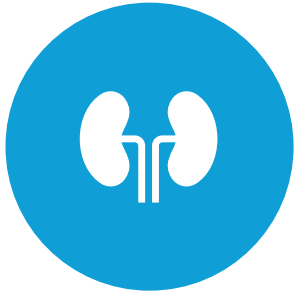
Discuss	Discuss risks, contributing factors, transplant-considerations, and treatment options for hypertension and hyperlipidemia post-transplant
Analyze	Analyze new treatment modalities for hyperlipidemia and their place in post-transplant care
Review	Review literature assessing GLP-1 agonists in the post-transplant setting

Hypertension

Risks

Cardiac remodeling

Stroke



Renovascular hypertension → CKD

Non-alcoholic fatty liver disease (NAFLD)

Post-Transplant Hypertension Pathophysiology

Calcineurin Inhibitors (CNI)

- Cyclosporine > tacrolimus
- Independent of nephrotoxicity
- Potential mechanisms
  - Increase activity of vasoconstrictors
  - Stimulate renin angiotensin aldosterone system (RAAS)
  - Inhibit production of vasodilator substances

Prednisone

- Salt retention

Essential Hypertension

Luke R. J. Am. Soc. Nephrol. 1991

Other Contributing Factors

- Fluid volume overload (FVO)
- Pain
- Obstructive sleep apnea (OSA)
- Other medications:
  - Serotonin and norepinephrine reuptake inhibitors (SNRI)
  - Oral contraceptives

Blood Pressure Goals

	BP Targets	BP Categories[a]	SBP (mm Hg)	DBP (mm Hg)
JNC 7, 2003	< 140/90 mm Hg < 130/80 mm Hg for those with diabetes or chronic kidney disease	Normal	< 120	< 80
		Prehypertension	120–139	80–89
		Stage 1 hypertension	140–159	90–99
		Stage 2 hypertension	≥ 160	≥ 100
JNC 8, 2014	< 150/90 mm Hg for patients ≥ 60 < 140/90 mm Hg for patients < 60, diabetes, and chronic kidney disease	Was not a comprehensive set of recommendations, and did not discuss hypertension diagnostic thresholds		
ACP/AAFP, 2017	< 150/90 mm Hg for patients ≥ 60 < 140/90 mm Hg for patients at higher CV risk, or with a history of stroke or TIA	Was not a comprehensive set of recommendations and did not discuss hypertension diagnostic thresholds Did not address recommendations in patients < 60		
ACC/AHA, 2017	≤ 130/80 mm Hg	Normal	< 120	< 80
		Elevated	120–129	< 80
		Stage 1 hypertension[b]	130–139	80–89
		Stage 2 hypertension	≥ 140	≥ 90

Whelton P, et al. Hypertension 2017

Hypertension Treatment

Lifestyle Modifications – 1st line for ALL

DIET

EXERCISE

STRESS REDUCTION

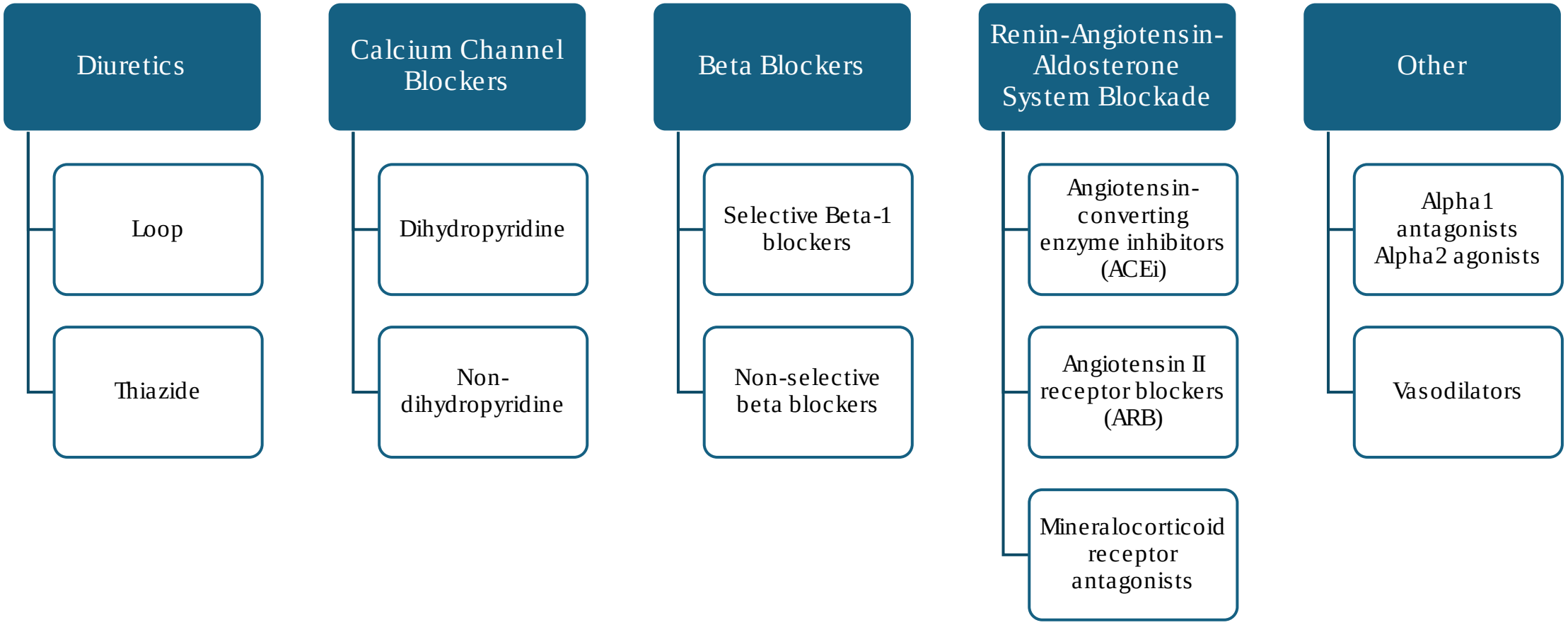
Tantisatamo E et al. Front Med (Lausanne). 2020

Non-Pharmacologic Treatment

	Nonpharmacological Intervention	Dose	Approximate Impact on SBP		
			Hypertension	Normotension	Reference
Weight loss	Weight/body fat	Best goal is ideal body weight, but aim for at least a 1-kg reduction in body weight for most adults who are overweight. Expect about 1 mm Hg for every 1-kg reduction in body weight.	−5 mm Hg	−2/3 mm Hg	(S6.2-1)
Healthy diet	DASH dietary pattern	Consume a diet rich in fruits, vegetables, whole grains, and low-fat dairy products, with reduced content of saturated and total fat.	−11 mm Hg	−3 mm Hg	(S6.2-6,S6.2-7)
Reduced intake of dietary sodium	Dietary sodium	Optimal goal is <1500 mg/d, but aim for at least a 1000-mg/d reduction in most adults.	−5/6 mm Hg	−2/3 mm Hg	(S6.2-9,S6.2-10)
Enhanced intake of dietary potassium	Dietary potassium	Aim for 3500–5000 mg/d, preferably by consumption of a diet rich in potassium.	−4/5 mm Hg	−2 mm Hg	(S6.2-13)
Physical activity	Aerobic	■ 90–150 min/wk ■ 65%–75% heart rate reserve	−5/8 mm Hg	−2/4 mm Hg	(S6.2-18,S6.2-22)
	Dynamic resistance	■ 90–150 min/wk ■ 50%–80% 1 rep maximum ■ 6 exercises, 3 sets/exercise, 10 repetitions/set	−4 mm Hg	−2 mm Hg	(S6.2-18)
	Isometric resistance	■ 4 × 2 min (hand grip), 1 min rest between exercises, 30%–40% maximum voluntary contraction, 3 sessions/wk ■ 8–10 wk	−5 mm Hg	−4 mm Hg	(S6.2-19,S6.2-31)
Moderation in alcohol intake	Alcohol consumption	In individuals who drink alcohol, reduce alcohol† to: ■ Men: ≤2 drinks daily ■ Women: ≤1 drink daily	−4 mm Hg	−3 mm Hg	(S6.2-22–S6.2-24)

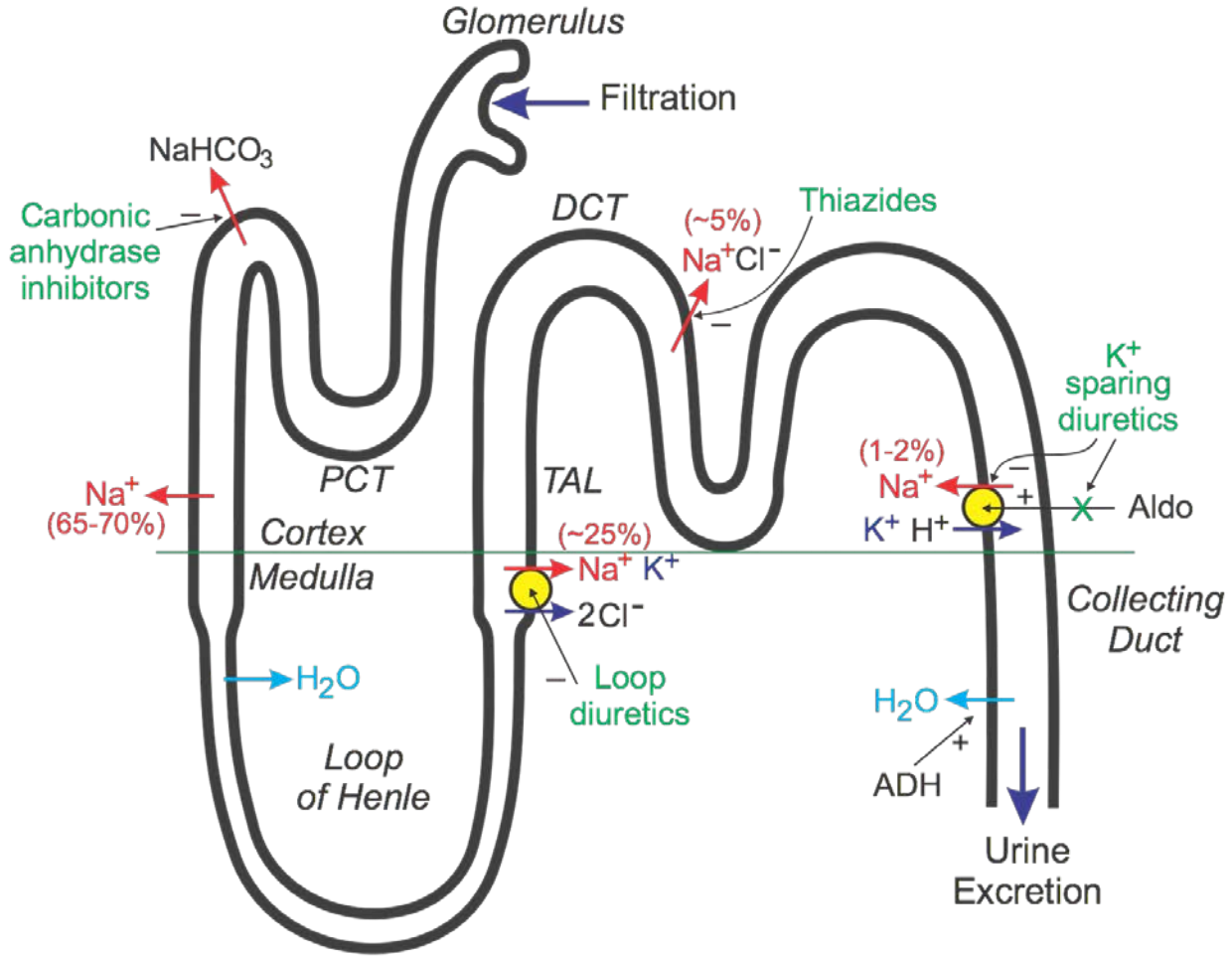
Tantisatamo E et al. Front Med (Lausanne). 2020

Pharmacologic Therapy



Diuretics

- Thiazide diuretics
  - Hydrochlorothiazide
  - Chlorthalidone
- Clinical Pearls:
  - Longer half-life than loop diuretics
    - furosemide, torsemide, bumetanide
  - Worsen gout
  - Lower magnesium, potassium, sodium, and calcium



Roush GC et al. J Cardiovasc Pharmacol Ther. 2014

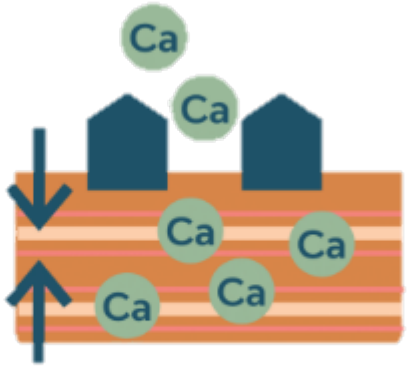
Calcium Channel Blockers

Dihydropyridine (DHP)

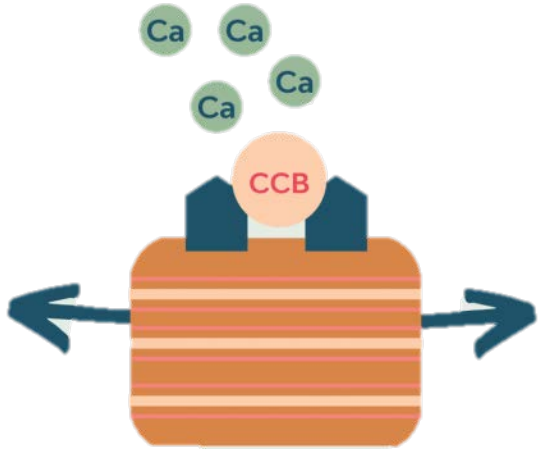
- Amlodipine, nifedipine, felodipine
  - Potential benefit with CNI toxicity
  - Peripheral edema

Non-dihydropyridine (non-DHP)

- Diltiazem, verapamil
  - Potential drug interactions due to moderate CYP3A4 inhibition
  - Bradycardia



Calcium influx into heart and vascular smooth muscles leads to vasoconstriction and contraction of these muscles.



Calcium channel blockers inhibit L- type calcium channels leading to vasodilation, decreased contractility, and a reduction in heart rate.

Dominic A, J Clin Hypertens (Greenwich). 2003

Beta Blockers

Selective Beta1 blockers

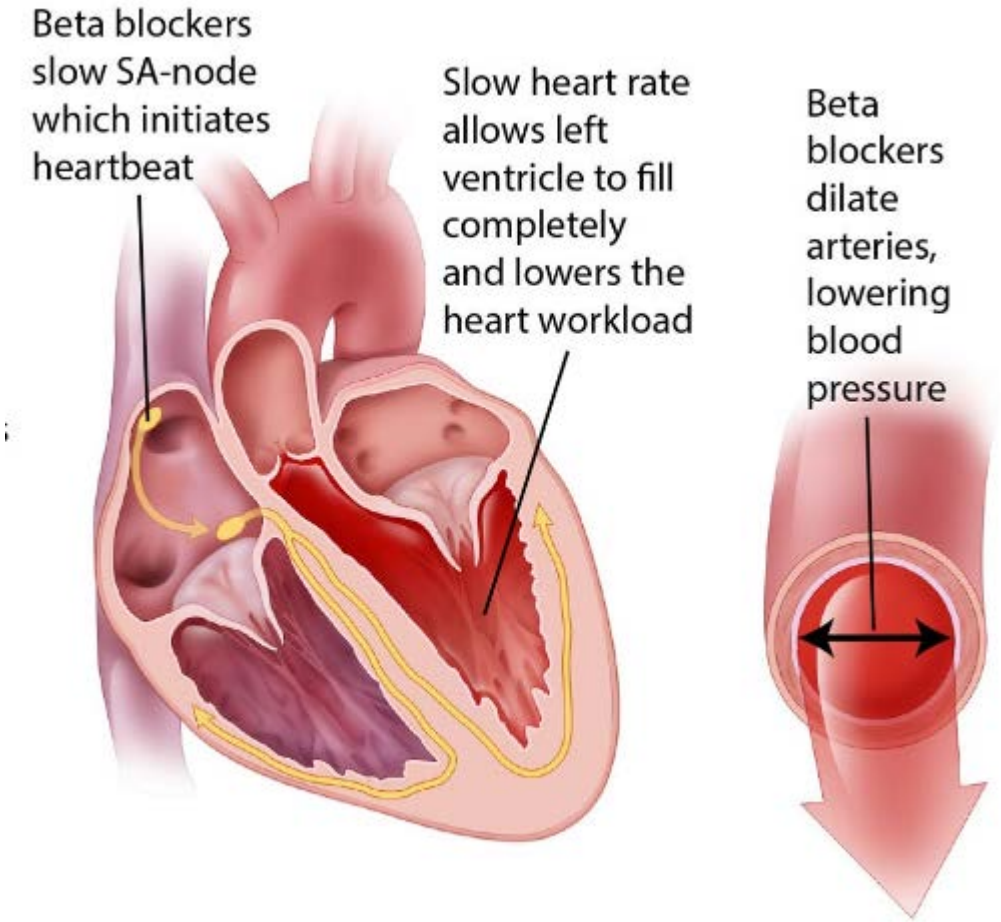
- Metoprolol, atenolol, nebivolol, esmolol

Non-selective

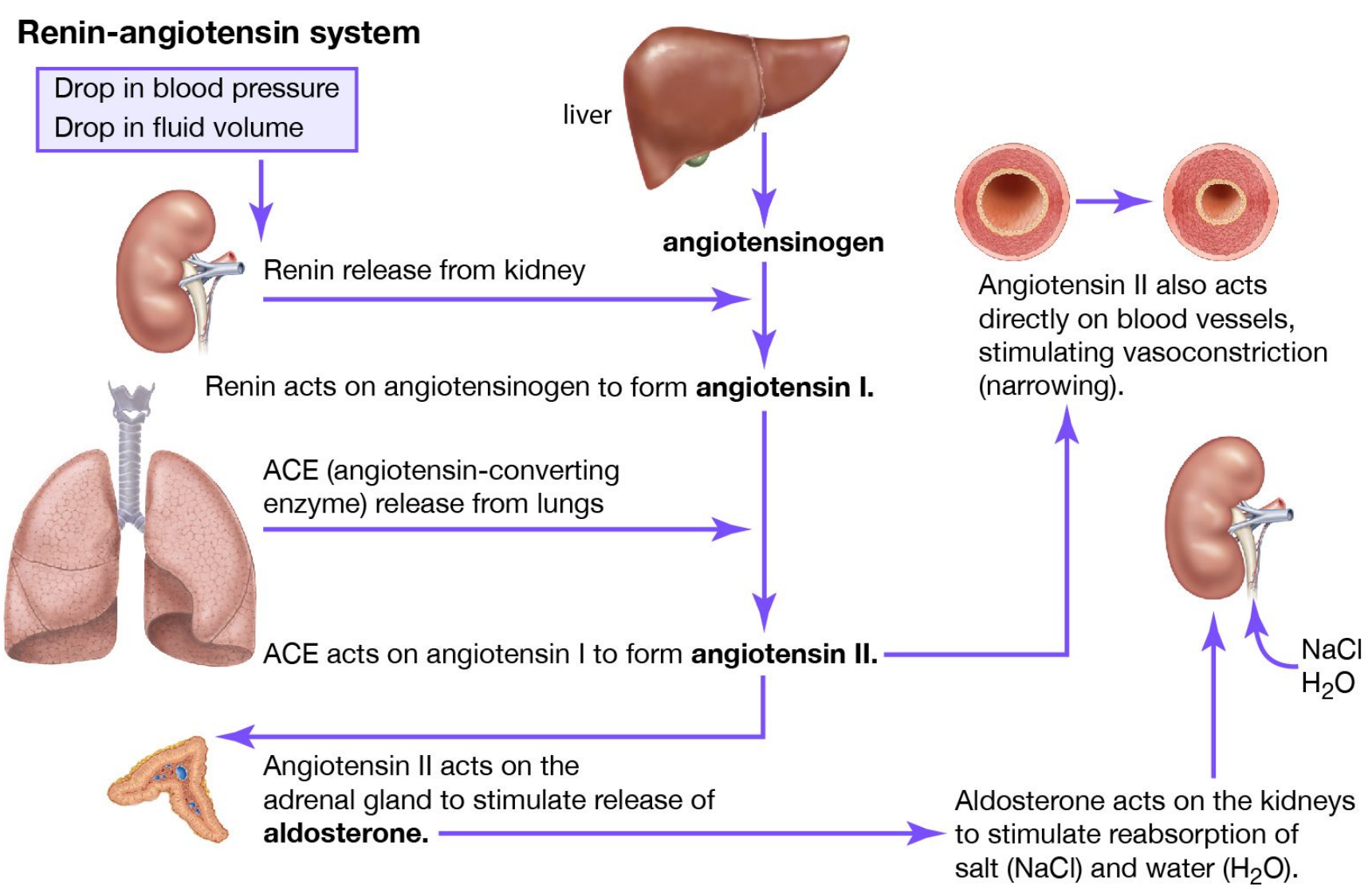
- Carvedilol, labetalol, propranolol

Clinical pearls:

- Caution in heart transplant
- Caution with airway disease (non-selective)
- Can be used for atrial fibrillation prophylaxis
- May improve tremors
- Fatigue
- ED



Masarone D, et al. Clin Transplant 2020



Fountain J, et al. Natl Lib Med. 2023

Renin-Angiotensin-Aldosterone System Blockade

Angiotensin-converting enzyme inhibitors (ACEi)

- Lisinopril, captopril, enalapril, ramipril

Angiotensin II receptor blockers (ARB)

- Losartan, candesartan, irbesartan, olmesartan, telmisartan, valsartan

Clinical Pearls:

- Improves proteinuria
- ACEi interaction with sirolimus
- Losartan reduces uric acid levels
- Acute kidney injury (AKI) -caution with CNI use
- Angioedema
- Hyperkalemia

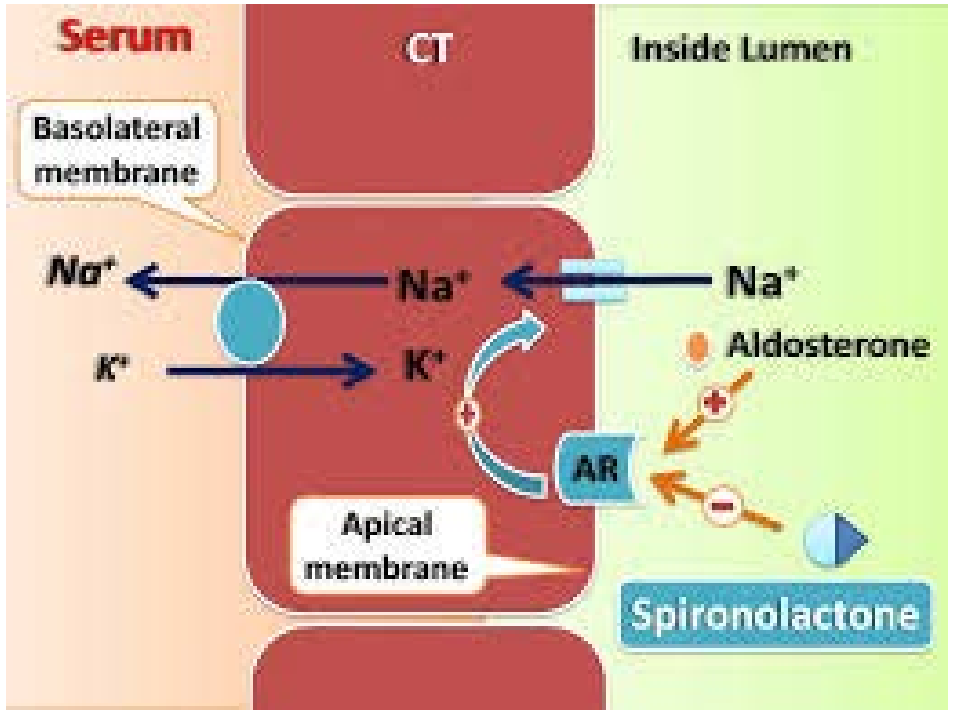
Renin-Angiotensin-Aldosterone System Blockade

Mineralocorticoid receptor antagonists

- Spironolactone
- Eplerenone

Clinical Pearls:

- Hyperkalemia
- Gynecomastia



Other Agents

Alpha1 antagonists

- Prazosin, doxazosin, tamsulosin, terazosin
  - Orthostatic hypotension
  - Treat benign prostatic hyperplasia (BPH), nightmares/post-traumatic stress disorder (PTSD)

Alpha2 adrenergic agonist

- Clonidine
  - Rebound hypertension!

Vasodilators

- Hydralazine
  - Can cause a lupus-like syndrome at high doses
  - Short half-life requires frequent dosing
- Minoxidil
  - Can treat alopecia
  - Should be used with diuretic and beta blockade

Fountain J, et al. Natl Lib Med. 2023

Organ-Specific Blood Pressure Considerations

Kidney

KDIGO 2009

- BP Goal <130/80 mmHg in adults
- Use any class of antihypertensive agent
- Monitor closely for adverse effects and drug-drug interactions
- When urine protein excretion is >1g/day for adults, consider an ACE-I or ARB for first-line therapy

ACC/AHA 2017

- BP Goal <130/80 mmHg
- It is reasonable to treat with calcium antagonist based on improved GFR and kidney survival

KIDGO. Hypertension. 2009

Procedural or Surgical Interventions in Kidney Transplant

- Transplant renal artery angioplasty/stenting
- Treatment of obstructive sleep apnea with continuous positive airway pressure (CPAP)
- Bilateral native nephrectomy (failed native kidneys)
- Native renal denervation (sympathetic overactivity)

Tantisattamo E, et al. Front Med. 2020

Liver

American Association for the Study of Liver Diseases (AASLD) 2012 Guidelines

- Goal BP 130/80 mmHg
- Combination of lifestyle modifications and pharmacological agents
- ACEi, ARBs and direct renin inhibitors should be used as first-line therapy in liver transplant recipients with DM, CKD, and or significant proteinuria

Lucey M et al. Liver Transplantation 19(1):p 3-26, January 2013

Heart

ISHLT 2023

- BP Goal same as recommended for the general population
- Treatment should include recommendations for lifestyle modification in addition to drug therapy
- ACEi and CCB may be preferred as first-line therapy in patients with DM and as a cardiac allograft vasculopathy (CAV) prevention strategy
- HCTZ could be considered to specifically counteract CNI-induced hypertension
- CCBs should be considered the antihypertensive drug of choice when optimal blood pressure control cannot be achieved with ACEi/ARB, or when these drugs are contraindicated in HT recipients

Velleca A, et al. JHLT. 2023

Lung

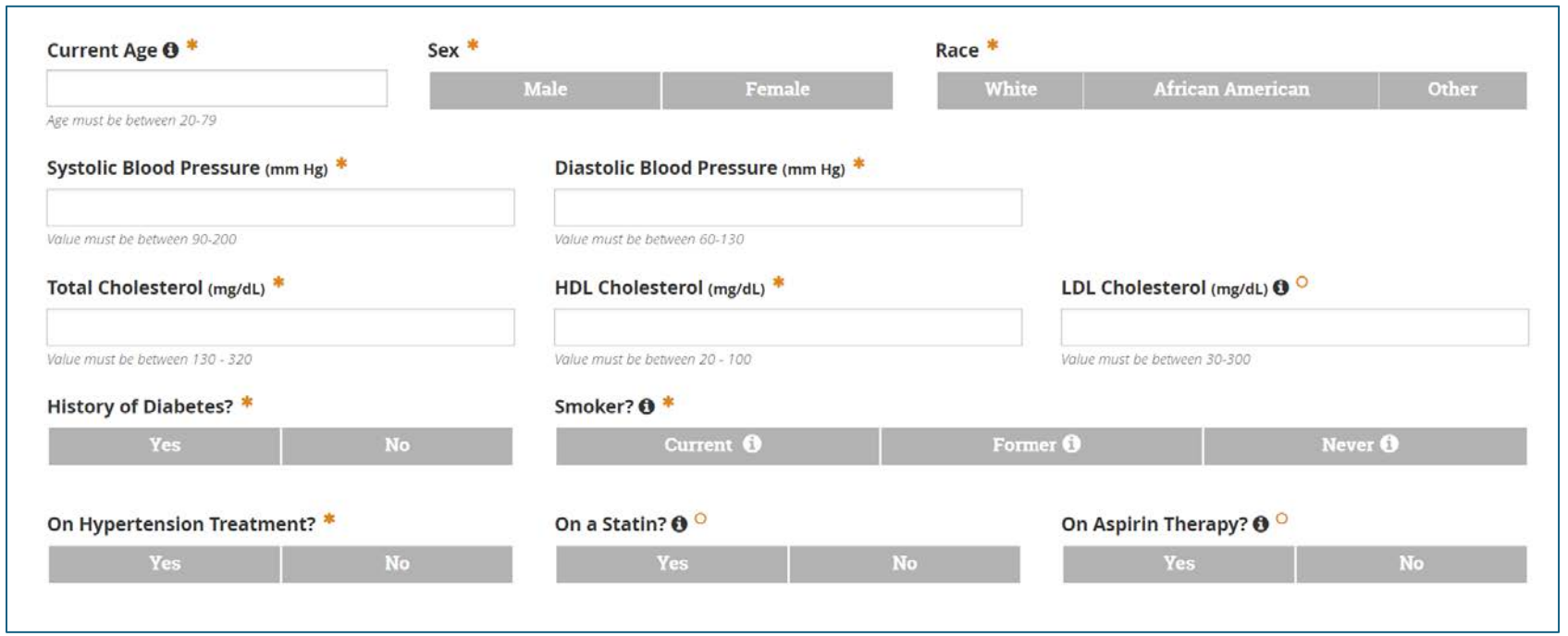
Hyperlipidemia (HLD)

Risks

High risk for the development of post-transplant cardiovascular disease (CVD)

Atherosclerosis is accelerated after transplantation

- Can be linked to cardiovascular events



https://tools.acc.org/ascvd-risk-estimator-plus/#!/calculate/estimate/

Contributing Factors to HLD Post-transplant

- Genetic predisposition
- Age
- Excessive intake of cholesterol / saturated fats
- Obesity
- Proteinuria
- Corticosteroids
- CNIs
- Mammalian target-of-rapamycin inhibitors (mTORi)

Goals – Primary Prevention

Benefit Group	First Line Therapy Based on 10-year ASCVD Risk	Goal
Baseline LDL ≥190 mg/dL	Any Risk High Intensity statin	>50% reduction and LDL<100 mg/dL or non-HDL <130 mg/dL
Age 40-75 years old with DM, baseline LDL <190mg/dL	**< 7.5%:** Moderate intensity statin	≥30-49% LDL reduction and LDL <100 or non-HDL <130 mg/dL
	>7.5%: risk enhancers, or subclinical atherosclerosis: high intensity statin	>50% reduction and LDL<100 mg/dL or non-HDL <130 mg/dL
	>20%: High intensity statin	>50% LDL reduction and LDL <70 or non-HDL <100
Age 40-75 years old without DM or ASCVD with LDL 70-189 mg/dL	**<5%:** Risk discussion	Lifestyle Modification
	5-7.4%: Consider moderate intensity statin	30-49% LDL reduction and LDL <100 mg/dL
	7.5 – 19.9%: Moderate intensity statin	30-49% LDL reduction and LDL <100 mg/dL
	≥20%: High intensity statin	>50% LDL reduction and LDL <70

Lloyd-Jones D, et al. JACC. 2022

Goals - Secondary Prevention

Benefit Group	First Line Therapy	Goal
ASCVD at high risk	High intensity statin	≥50% reduction in LDL and LDL <55 mg/dL or non–HDL <85 mg/dL
ASCVD not at very risk	High intensity statin	≥50% reduction in LDL and LDL <70 mg/dL or non–HDL <100 mg/dL
ASCVD and LDL ≥190 mg/dL	High intensity statin	≥50% reduction in LDL and LDL <70 mg/dL or non–HDL <100 mg/dL

Lloyd-Jones D, et al. JACC. 2022

Hyperlipidemia Treatment

Lifestyle Modification

DIET

EXERCISE

SMOKING CESSATION

ALCOHOL REDUCTION / CESSATION

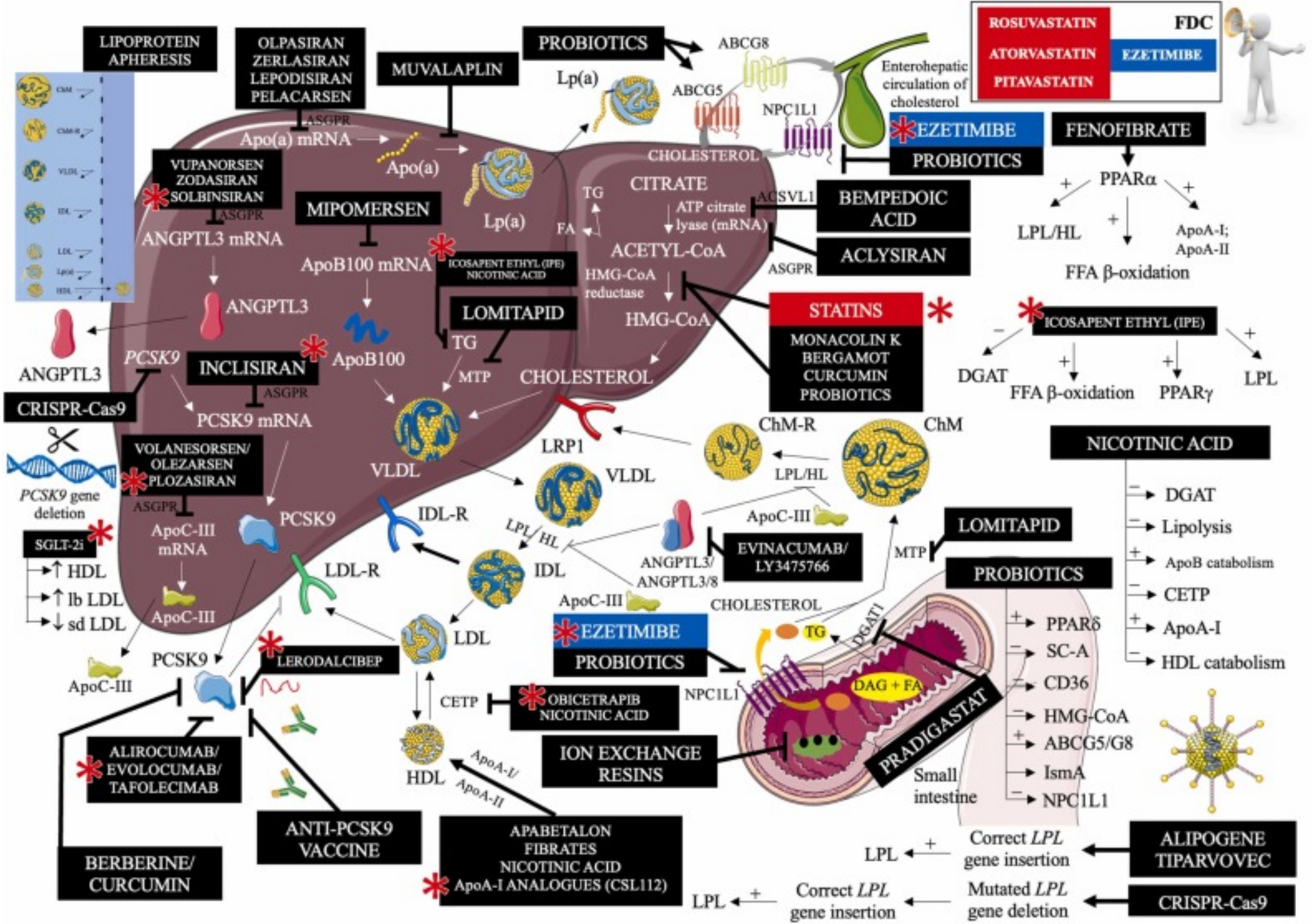
Pharmacologic Therapy

First-line

- Hydroxymethylglutaryl-CoA (HMG-CoA) reductase inhibitors

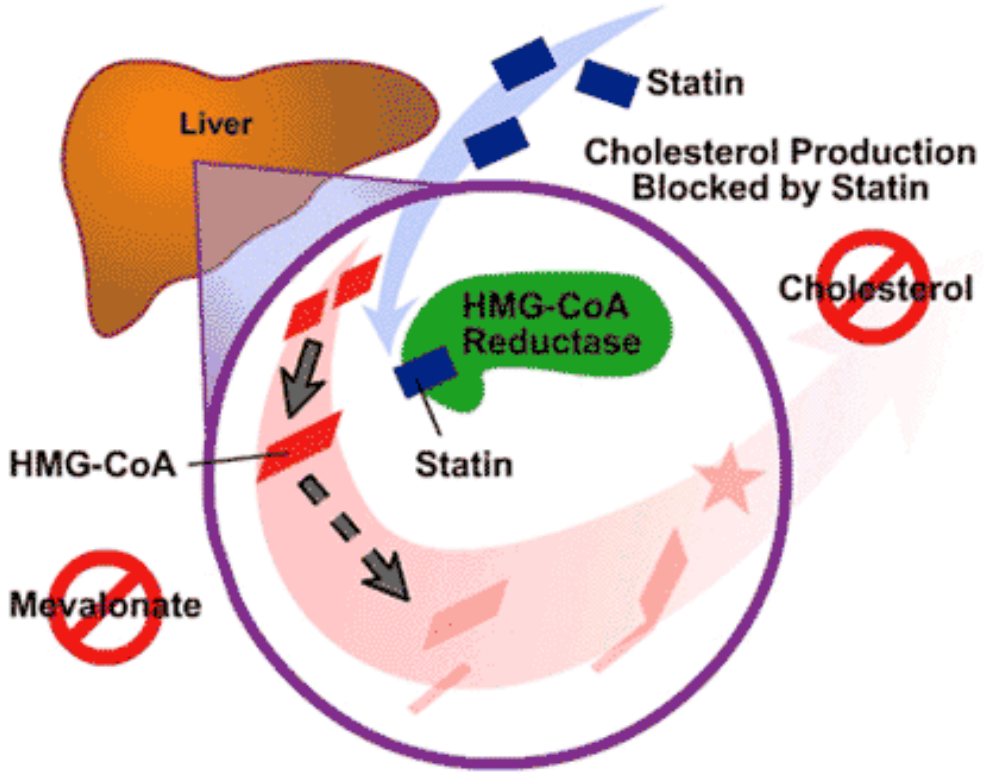
If Goals not met:

- Ezetimibe
- Bile acid sequestrants
- Niacin
- Fibrates
- Proprotein convertase subtilisin-kexin type 9 (PCSK9) inhibitors
- Microsomal triglyceride transfer protein (MTP) inhibitors
- Angiopoietin-like protein 3 (ANGPTL3)
- Antilipemic Small Interfering Ribonucleic Acid (siRNA) Agent


LIPOPROTEIN APHERESIS
OLPASIRAN ZERLASIRAN LEPODISIRAN PELACARSEN
MUVALAPLIN
PROBIOTICS
ABCG8
ABCG5
NPC1L1
Enterohepatic circulation of cholesterol
ROSUVASTATIN
ATORVASTATIN
PITAVASTATIN
FDC
EZETIMIBE
EZETIMIBE
PROBIOTICS
FENOFIBRATE
PPARα
LPL/HL
ApoA-I; ApoA-II
FFA β-oxidation
Lp(a)
Apo(a) mRNA
Apo(a)
ASGPR
VUPANORSEN ZODASIRAN SOLBINSIRAN
ANGPTL3 mRNA
MIPOMERSEN
ApoB100 mRNA
ICOSAPENT ETHYL (IPE) NICOTINIC ACID
LOMITAPID
CHOLESTEROL
CITRATE
ATP citrate lyase (mRNA)
ACSVL1
BEMPEDOIC ACID
ACLYSIRAN
ACETYL-CoA
HMG-CoA reductase
HMG-CoA
TG
FA
STATINS
MONACOLIN K
BERGAMOT
CURCUMIN
PROBIOTICS
ICOSAPENT ETHYL (IPE)
DGAT
FFA β-oxidation
PPARγ
LPL
ANGPTL3
PCSK9
INCLISIRAN
ApoB100
MTP
CRISPR-Cas9
PCSK9 mRNA
PCSK9 gene deletion
VOLANESORSEN/ OLEZARSEN PLOZASIRAN
ApoC-III mRNA
SGLT-2i
↑ HDL
↑ lb LDL
↓ sd LDL
ApoC-III
VLDL
LRP1
ChM-R
ChM
LPL/HL
NICOTINIC ACID
DGAT
Lipolysis
ApoB catabolism
CETP
ApoA-I
HDL catabolism
IDL-R
LPL/HL
IDL
ANGPTL3/ ANGPTL3/8
EVINACUMAB/ LY3475766
ApoC-III
LOMITAPID
MTP
PROBIOTICS
LDL-R
LDL
CHOLESTEROL
TG
DGAT1
EZETIMIBE
PROBIOTICS
PPARδ
SC-A
CD36
HMG-CoA
ABCG5/G8
IsmA
NPC1L1
PCSK9
LERODALCIBEP
CETP
OBICETRAPIB NICOTINIC ACID
NPC1L1
DAG + FA
PRADIGASTAT
Small intestine
HDL
ApoA-I/ ApoA-II
ION EXCHANGE RESINS
ALIROCUMAB/ EVOLOCUMAB/ TAFOLECIMAB
ANTI-PCSK9 VACCINE
APABETALON FIBRATES NICOTINIC ACID ApoA-I ANALOGUES (CSL112)
BERBERINE/ CURCUMIN
LPL
Correct LPL gene insertion
ALIPOGENE TIPARVOVEC
Mutated LPL gene deletion
CRISPR-Cas9

HMG CoA Reductase Inhibitors

- Lovastatin, simvastatin, and atorvastatin are metabolized via CYP3A4
- All statins are substrates of OATP1B1 transporter
  - Using them with CNIs increases statin concentrations
  - Increased risk of myalgias / rhabdomyolysis
- Cholesterol synthesis occurs at night, so statins should be administered in the evening



Bansal A, et al. HMG CoA Reductase Inhibitors. Natl Lib Med. 2023

HMG CoA Reductase Inhibitors

Drug	Low Intensity 20-25% ↓	Moderate Intensity 30-49% ↓	High Intensity ≥50% ↓	Clinical Pearls
Lovastatin	10-20 mg	40-80 mg		Metabolized via CYP3A4 Short half-life
Pravastatin	10-20 mg	40-80 mg		
Simvastatin	10 mg	20-40 mg		Metabolized via CYP3A4 Can cause kidney injury Short half-life
Fluvastatin	20-40 mg	80 mg		Short half-life
Pitavastatin		1-4 mg		
Atorvastatin	5 mg	10-20 mg	40-80 mg	Metabolized via CYP3A4
Rosuvastatin		5-10 mg	20-40 mg	Can cause kidney injury

Bansal A, et al. HMG CoA Reductase Inhibitors. Natl Lib Med. 2023

Non-statin therapies

Drug Class	Mechanism of Action	LDL-C Lowering	Side Effects
Ezetimibe	- Reduces cholesterol absorption in the small intestine - Raise LDL receptor activity	15-25%	GI
Bile acid sequestrants	- Impairs absorption of cholesterol - Raise LDL receptor activity	15-25% depending on dose	Constipation GI Increases TG *Contraindicated with MMF *Decreases statin concentration
Niacin	- Reduces hepatic secretion of VLDL	5-20%	Flushing Rash Increased plasma glucose Hepatic dysfunction
Fibrates	- Reduces secretion of VLDL - Enhances degradation of VLDL	5-15%	Myopathy (in combination with statins)

Grundy S et al. Guidelines for the Management of High Blood Cholesterol. Natl Lib Med 2022

Non-statin therapies

Drug Class	Mechanism of Action	LDL-C Lowering	Side Effects
PCSK9 inhibitors (alirocumab, evolocumab, lerodalcibep)	Inhibits PCSK9 to increase the number of LDL receptors available to clear circulating LDL-C	45%-60%	Headache, injection-site reaction
MTP inhibitors (lomitapide)	Reduces hepatic secretion of VLDL	50%+	Fatty liver, hepatotoxicity
Evinacumab	Blocks angiopoietin-like protein 3 (ANGPTL3)	~50%	Infusion reactions
Inclisiran	Antilipemic Small Interfering Ribonucleic Acid (siRNA) Agent Inhibits PCSK9 production in the liver	48% - 52%	Injection site reactions

PCSK9 Inhibitors

Agent	Dosing	Adverse Effects	Other Considerations
Evolocumab (Repatha®)	140mg SQ every 2 weeks	Injection site reactions Angioedema (rare) Potential for immunogenicity Flu-like illness	Avoid with latex allergy
Alirocumab (Praluent®)	75mg SQ every 2 weeks		May cause LFT elevation
Lerodalcibep	300mg SQ monthly		Third generation

PCSK9i in SOT

Warden B, et al. J Am Coll Cardiol Case Rep 2020

CASE REPORT: CLINICAL CASE SERIES

Use of PCSK9 Inhibitors in Solid Organ Transplantation Recipients

Bruce A. Warden, PharmD,[a] Tina Kaufman, PhD, PA-C,[a] Jessica Minnier, PhD,[a,b] P. Barton Duell, MD,[a] Sergio Fazio, MD, PhD,[a] Michael D. Shapiro, DO, MCR[a,c]

Results

- Case series of 12 SOT recipients with inadequately treated HLD with standard lipid lowering therapy
  - 75% heart transplant
  - Kidney, liver, and lung also represented
- Indications were familial HLD (50%), ASCVD risk (75%) and CAV (18%)
- Median LDL-C levels decreased 60%
- Median CSA levels decreased (37%), tacrolimus increased (6%)
  - Proportion of time within therapeutic range did not change
- 25% of patients experienced mild, self-limiting adverse reactions
  - Rhinorrhea, injection site reactions, nausea
  - No discontinuation

Warden B, et al. J Am Coll Cardiol Case Rep 2020

Organ Specific Considerations

Kidney

- KDIGO 2013
  - Statin treatment for all adult kidney transplant recipients (KTRs), except those aged <30 years of age and without prior cardiovascular risk factors (CVRF)

KIDGO. Hypertension. 2013

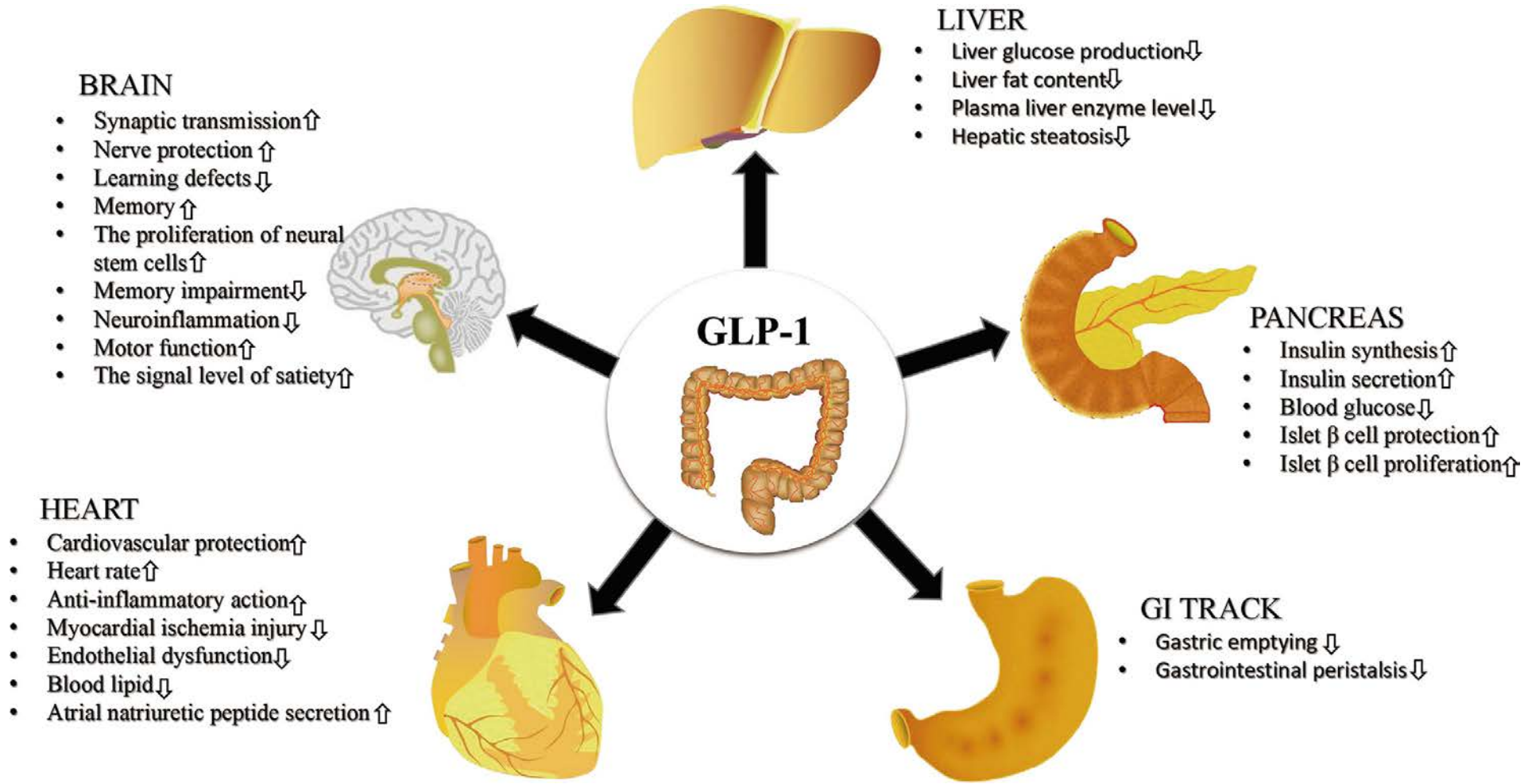
Heart

- ISHLT 2023
  - In adults, the use of statins after HT is recommended regardless of cholesterol levels. Due to pharmacologic interactions with CNI and risk for toxicity, statin doses should generally be lower than those recommended for hyperlipidemia.
  - Although there is no evidence for a target LDL concentration in these patients, it is reasonable to aim for level below 100 mg/dL (or 2.5 mmol/L) for most patients, with more aggressive targets reserved for those with evidence of CAV
  - PCSK9 inhibitors are reasonable adjuncts to statins in adult heart transplant patients with uncontrolled hyperlipidemia or as alternative agents in the setting of statin intolerance

Velleca A, et al. JHLT. 2023

Glucagon-Like Peptide-1 Agonists

Talk of the Town



Zhao X, et al. Front. Endocrinol., 22 August 2021

Cardiovascular Benefits of GLP1-A

- Improvement in multiple cardiovascular risk factors:
  - Reduction in systolic blood pressure (2-6 mmHg)
  - Reduction in total cholesterol, LDL and triglycerides
  - Hemoglobin A1c reduction from 0.8 – 1.5%
  - Weight reduction (2.5 – 4kg)
- 15% reduction in major adverse cardiovascular events (MACE)

Marx N, et al. Circulation 2022

Post-Transplant Concerns

Safety

Tolerability

- GI adverse effects
  - Delayed gastric emptying
  - Medication absorption

Efficacy

- How can these agents benefit transplant patients?

Kidney Transplantation

OPEN

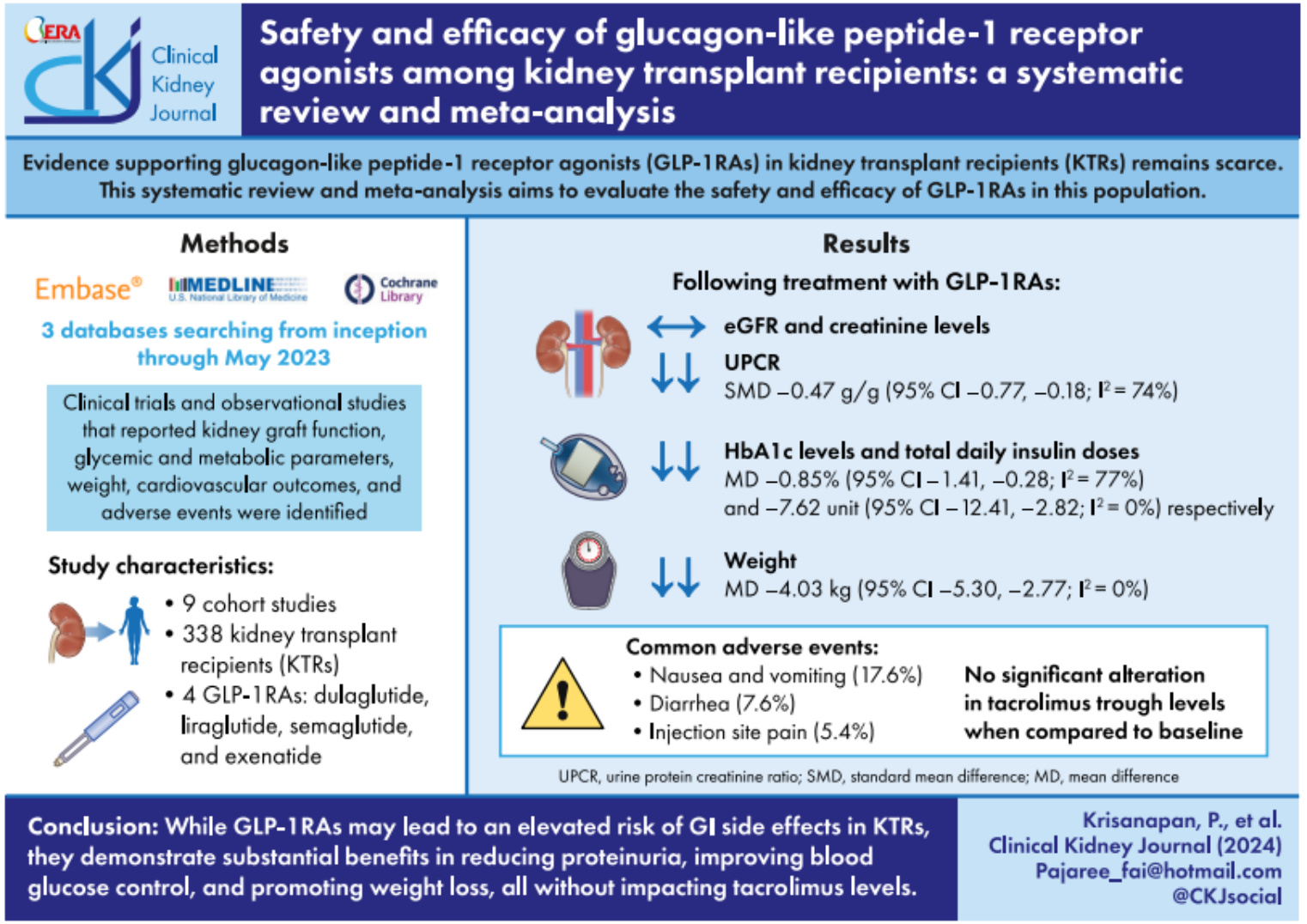
The Use of GLP1R Agonists for the Treatment of Type 2 Diabetes in Kidney Transplant Recipients

Aleksandra Kukla, MD,[1] Jennifer Hill, DNP,[1] Massini Merzkani, MD,[1] Andrew Bentall, MD,[1] Elizabeth C. Lorenz, MD,[1] Walter D. Park, BS,[2] Matthew D'Costa, MD,[2] Yogish C. Kudva, MD,[3] Mark D. Stegall, MD,[2] and Pankaj Shah, MD[3]

Results

- 14 kidney transplant patients
  - 12-month outcomes:
    - No change in weight
    - Decrease in total daily insulin dose
    - No change in renal function
    - No significant change in tacrolimus dose
  - Tolerability
    - 5 patients discontinued (29%)
      - Pancreatitis
      - Nausea
      - Diarrhea
      - Fatigue
      - Uncontrolled DM

Kidney Meta-Analysis



Semaglutide is effective in achieving weight loss in liver transplant recipients

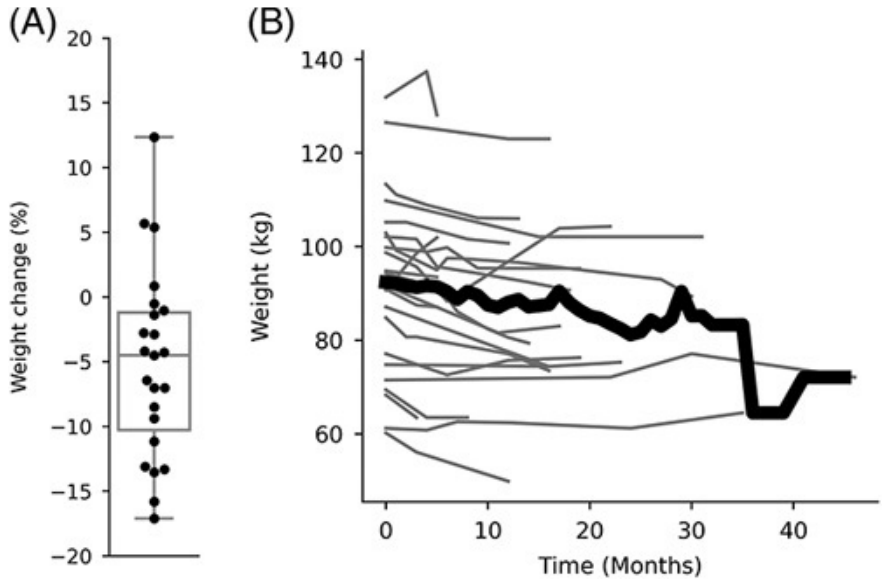
Chow, Kenneth W.[1]; Ibrahim, Brittney[2,3]; Rahal, Kabir[2]; Hsu, Ryan H.[4]; Tan, Teresa[2]; Meneses, Katherine[2]; Saab, Sammy[2,3]

Author Information

Liver Transplantation 30(2):p 223-225, February 2024. | ***DOI:*** 10.1097/LVT.0000000000000247

Results

- 23 OLT recipients
- Indication:
  - 70% T2DM
  - 26.1% Obesity
  - 4.3% NAFLD
- Statistically significant decrease in mean body weight (92kg → 87kg)
- Lower doses than package insert were used
- Adverse effects:
  - Nausea (30.4%)
  - Emesis (26.1%)
  - Diarrhea (30.4%)
  - Early satiety (8.7%)



NAFLD: nonalcoholic fatty liver disease

Clinical TRANSPLANTATION
The Journal of Clinical and Translational Research

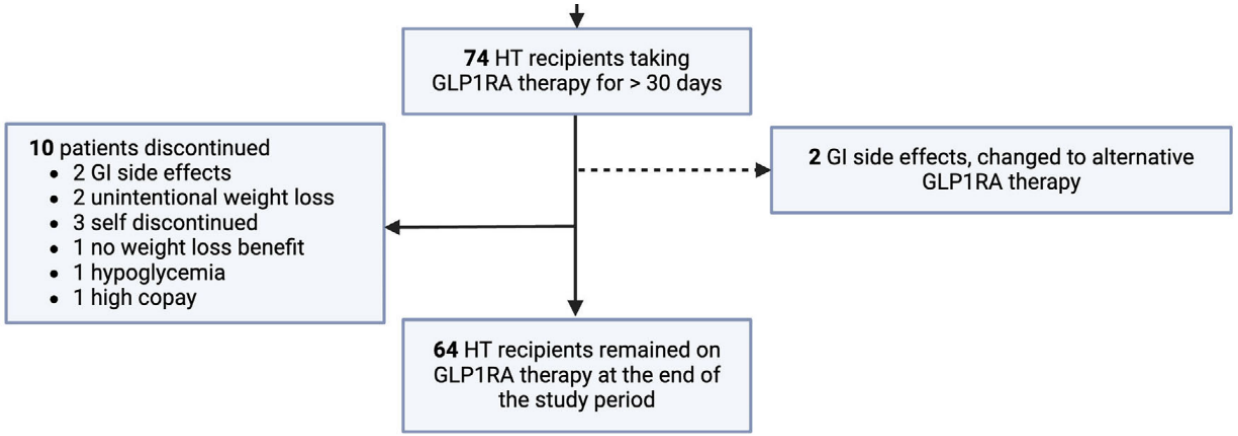
ORIGINAL ARTICLE

Cardio-Renal-Metabolic Outcomes Associated With the Use of GLP-1 Receptor Agonists After Heart Transplantation

Elena M. Donald | Elissa Driggin | Jason Choe | Jaya Batra | Fabian Vargas | Jordan Lindekens | Justin A. Fried | Jayant K. Raikhelkar | David J. Bae | Kyung T. Oh | Melana Yuzefpolskaya | Paolo C. Colombo | Farhana Latif | Gabriel Sayer | Nir Uriel | Kevin J. Clerkin | Ersilia M. DeFilippis

Department of Medicine, Division of Cardiology New York Presbyterian Hospital/Columbia University Irving Medical Center, New York, New York, USA

Results



- 74 HT recipients
- Indications were T2DM and/or obesity
- 16% discontinued for adverse effects
- 6.8% required significant change in CNI dosage after initiation of GLP-1 agonist
  - 3 required CNI decrease
  - 2 required CNI increase

Results

TABLE 2 | Cardiometabolic profile before and after GLP1-RA Therapy.

Variable	Baseline	Most recent follow-up	Significance (*p*-value)
BMI (kg/m^2)	33.3 (6.9)	31.5 (6.5)	<0.0001
HbA1C (%)	7.3 (1.6)	6.7 (1.4)	0.0005
LDL (mg/dL)	78.6 (36.7)	70.3 (32.5)	0.018
TG (mg/dL)	148.1 (75.4)	137.8 (64.9)	0.200
eGFR (mL/min/1.73m^2)	57.2 (19.7)	56.1 (20.1)	0.588
NT-proBNP (pg/mL)	435 [252, 1070]	317 [153, 787]	0.746
Urine protein (mg/dL)	28 [9.8, 57]	31 [18.5, 187]	0.442
Insulin dose (units)	32.6 (17.1)	24.8 (16.5)	0.0003
Prednisone dose (mg)	4.5 [2.5, 5.0]	2 [0, 3]	0.0006

Note: Values are mean (SD) or median [Q1, Q3].

Abbreviations: BMI, body mass index; eGFR, estimated glomerular filtration rate; HbA1C, hemoglobin A1C; HT, heart transplant; LDL, low density lipoprotein; NT-proBNP, N-terminal pro-B-type natriuretic peptide; TG, triglycerides.

Summary

- Refer to organ specific guidance (where available) for hypertension and lipid management
- Use medication clinical pearls to help guide difficult clinical decision making / agent selection
- GLP1 agonists have been safely and effectively used in the post-transplant setting but require careful patient selection and monitoring

Hypertension, Hyperlipidemia, and GLP-1 agonists After Transplantation

Maddy Morrison, PharmD BCTXP
Vanderbilt University Medical Center