Diabetes and Common Blood Investigations

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Learning Outcomes

Aims

This session aims to develop your skills in interpreting blood tests related to diabetes and CVD.

Learning Outcomes

- Interpret blood glucose levels, HbA1c, lipid profile, kidney function tests, and other relevant blood tests for diabetes and CVD.
- Identify abnormal test results and understand their implications in the context of diabetes and CVD management.
- Use blood test results to guide treatment plans, adjust medication dosages, and recommend lifestyle changes.
- Recognise the risk factors and potential complications of diabetes and CVD as indicated by blood test results.
- Effectively communicate test results and their clinical significance to patients and other healthcare professionals.

Diagnostic Criteria for Type 2 Diabetes

Measurement	Normal	NDH (Increased Risk of Diabetes)	Diabetes
Random plasma glucose	≤7.0mmol/l	Not Applicable	≥11.1mmol/l
Fasting plasma glucose (FPG)	≤6.9mmol/l	5.5-6.9mmol/l	≥7.0mmol/l
HbA1c	<42mmol/mol	42-47mmol/mol	≥48mmol/mol
2 hour Oral Glucose Tolerance Test (OGTT)	≤7.7mmol/l	7.8 – 11.0mmol/l	≥11.1mmol/l

Normal HbA1c 15 to 42mmol/mol

HbA1c

Advantages:

Does not require fasting
Quick and convenient test
Low biological variability
A measure of prior glycaemia

Disadvantages:

Exclusion criteria
More expensive
Laboratory analytical differences

HbA1c

HbA1c- Exclusion Criteria

- Children and young people
- Pregnant women, or women who have been pregnant in the last 2 months
- Type 1 Diabetes
- Patients at high risk of diabetes who are acutely ill
- Patients taking drugs < 2 months which can cause an acute rise in blood glucose-e.g. Steroids
- Patients with acute pancreatic damage / pancreatic surgery
- Abnormal HB/ Anaemia / Ethnicity / Renal Failure

HbA1c- Unexpected Results

High HbA1c:
Vitamin B12 deficiency
Iron deficiency
Chronic renal failure
Splenectomy

Low HbA1c
Administration of iron/vitamin B12
Chronic liver disease
CKD stage 4/5
Haemolytic anaemias
Recent blood donation

Variable HbA1c
Haemoglobinopathies

References: ABCD position statement
Practical Diabetes Int July/August 2010 Vil. 27 No 6

Fructosamine

- Glucose attached to plasma proteins
- Fructosamine is proportional to the mean blood glucose of an individual over the previous 1–3 weeks
- NICE Guidelines indicate that fructosamine should not be used as a replacement for HbA1c in the general diabetic population
- Unreliable when there are abnormalities of plasma protein concentrations e.g. in nephrotic syndrome, liver cirrhosis, and in untreated thyroid disease

Glucose (mg/dl) Fructosamine (umol) HbA1C (%)

Fructosamine	HbA1C (%)	HbA1C (mmol/mol)
212.5	5.0	31
250	6.0	42
287.5	7.0	53
325	8.0	64
362.5	9.0	75
400	10.0	86
437.5	11.0	97
475	12.0	108

Uncertain Diagnosis:

C-peptide:

- Indicator of severe insulin deficiency and beta cell function
- <200pmmol/L

Pancreatic Autoantibodies:
Anti-GAD65,IAA, ZnT8A,and ICA

- Present at the time of diagnosis in 60-70% of people
- Antibody titre declines with time
- Amount of antibody positive patients decrease to 10-40% after 10-12 years

C-peptide levels in differentiation of type 1 and type 2 diabetes - GPnotebook

Overview | Type 1 diabetes in adults: diagnosis and management | Guidance | NICE

Baseline Investigations at Diagnosis

HbA1c

Full Lipid Profile

U&E's

Serum Creatinine/eGFR

FBC/TSH/Vitamin D

Urine-albumin/creatinine ratio (ACR)

Blood Investigations for Annual Review

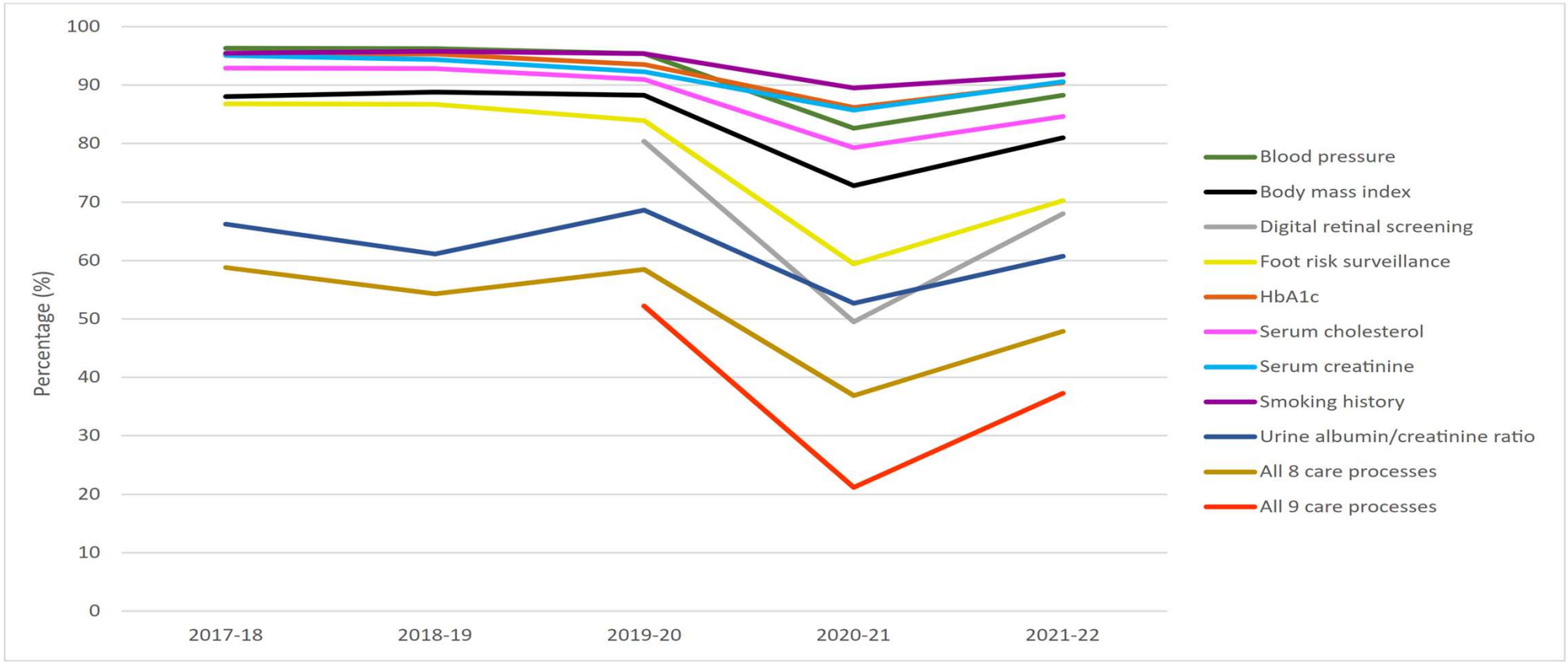
HbA1c

Lipids

U&E's

Serum Creatinine/eGFR

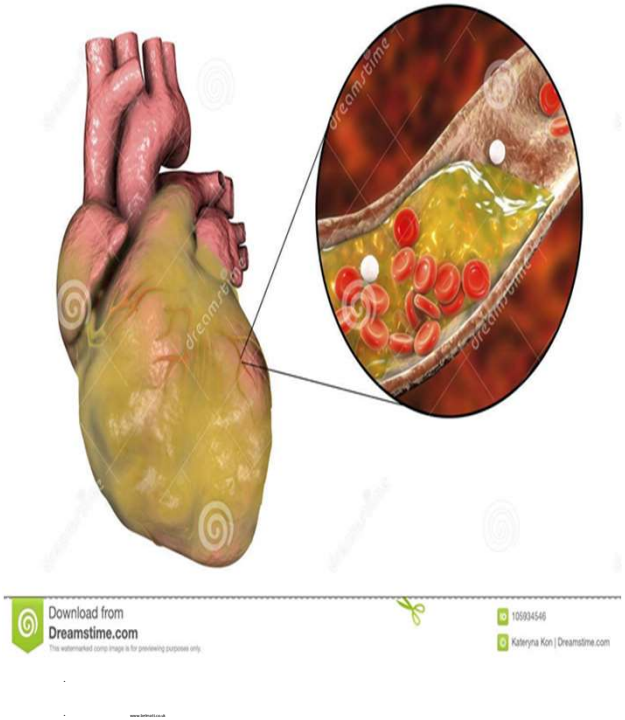
Urine-albumin/creatinine ratio (ACR)



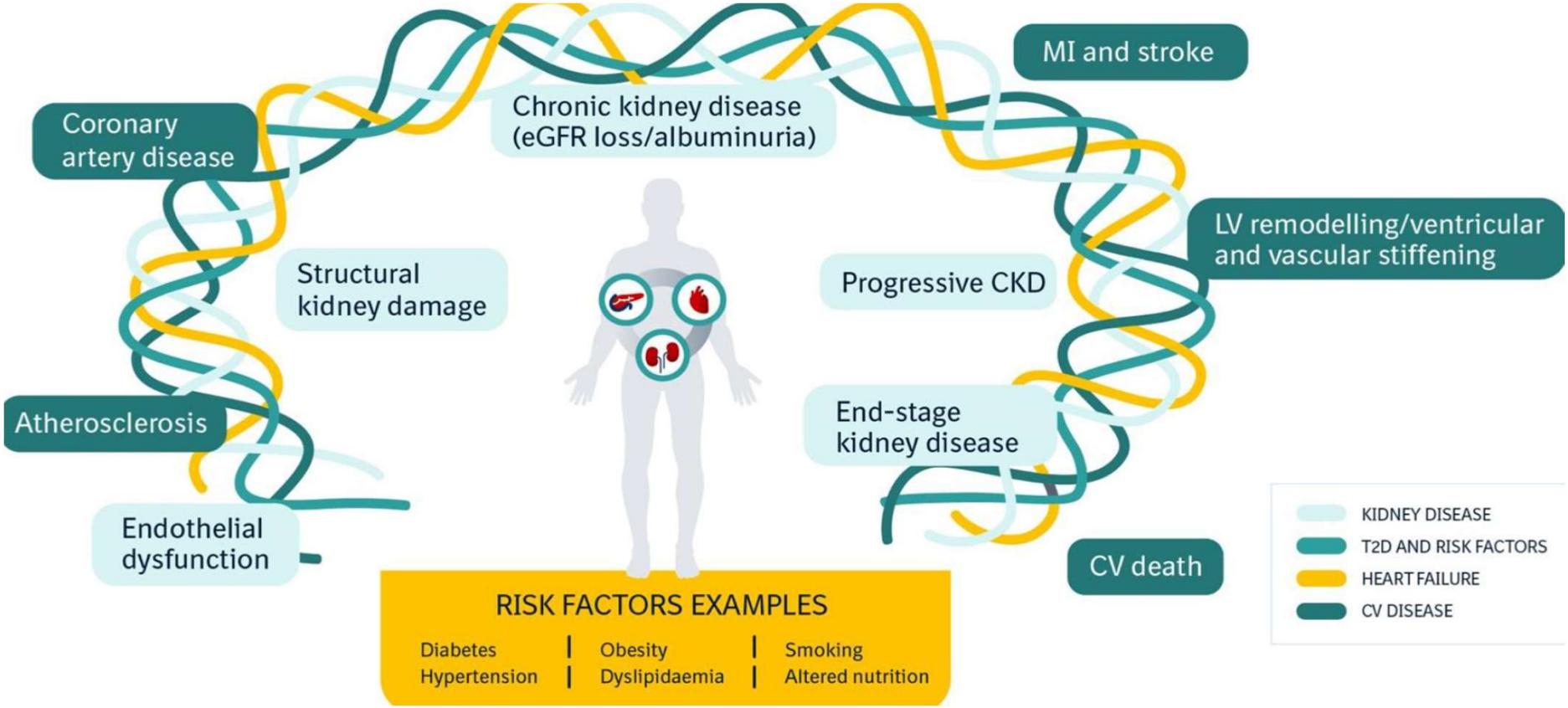
NDA Data 2021-2022

National Diabetes Audit 2021-22, Report 1: Care Processes and Treatment Targets, Overview - NHS Digital

Inflammatory Response



- Hyperglycaemia
- Insulin Resistance
- Visceral Obesity
- Pro-Inflammatory cytokines
- Free fatty Acids
- Plaque formation



www.belmatt.co.uk

What Can We Do?:

Find

- Opportunistic surveillance
- Routine screening-on admission
- Clinical history-signs and symptoms
- QRisk Score3- QRISK3
- Family history
- Identifying risk factors
- Investigations

Triple Targets

Parameter	Independent	Dependent /Frail
HbA1c	53–58.5 mmol/mol)	63.9–69.4 mmol/mol)
BP	130/80 mmHg	150/90 mmHg
Lipids	Statins Started **Non-HDL** 40% reduction from baseline < 2.5mmo/L **Total Cholesterol**< 4mmol/L LDL < 2mmol/L	

Lipid Profiles

- Modification of the blood lipid profile can reduce CVD risk.
- Total cholesterol is an important predictor of CVD events. However, non-high density lipoprotein cholesterol (non-HDL-C) — the difference between total and HDL-C is a powerful risk factor.
- Non-HDL-C has replaced low-density lipoprotein cholesterol (LDL-C) as the primary target for reducing cardiovascular risk with lipid-modifying treatment.
- A raised triglyceride level is a risk factor for CVD and is independent of total cholesterol

Update information | Cardiovascular disease: risk assessment and reduction, including lipid modification | Guidance | NICE

Lipid modification - CVD prevention | Health topics A to Z | CKS | NICE

Initiating Lipid Therapy

- Before starting lipid modification therapy, the following baseline blood tests should be performed:
  - A non-fasting lipid profile.
  - Liver function tests (transaminases).
  - Renal function, including estimated glomerular filtration rate.
  - HbA1c.
  - Creatine kinase (if the person has persistent generalized unexplained muscle pain).
  - Thyroid stimulating hormone in people with symptoms of underactive or overactive thyroid.

Lipid modification - CVD prevention | Health topics A to Z | CKS | NICE

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Lipid Management

- Full lipid profile= total cholesterol, non-HDL cholesterol
  HDL- high density lipoprotein and triglyceride

- Aim for non-HDL-C reduction by 40% from baseline.
  If not achieved, use target non-HDL-C <2.5 mmol/L.

Lipid modification - CVD prevention | Health topics A to Z | CKS | NICE

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Triglyceride Management

Triglyceride concentration between **10 and 20 mmol/litre**:

- repeat the triglyceride measurement with a fasting test
- review for potential secondary causes of hyperlipidaemia
- seek specialist advice if the triglyceride remains over 10 mmol/ litre.

Triglyceride concentration between **4.5 and 9.9 mmol/ litre**:

- optimise the management of other CVD risk factors present
- seek specialist advice if non-HDL cholesterol concentration is over 7.5 mmol

Update information | Cardiovascular disease: risk assessment and reduction, including lipid modification | Guidance | NICE

Chronic Kidney Disease: Classification of Renal Impairment

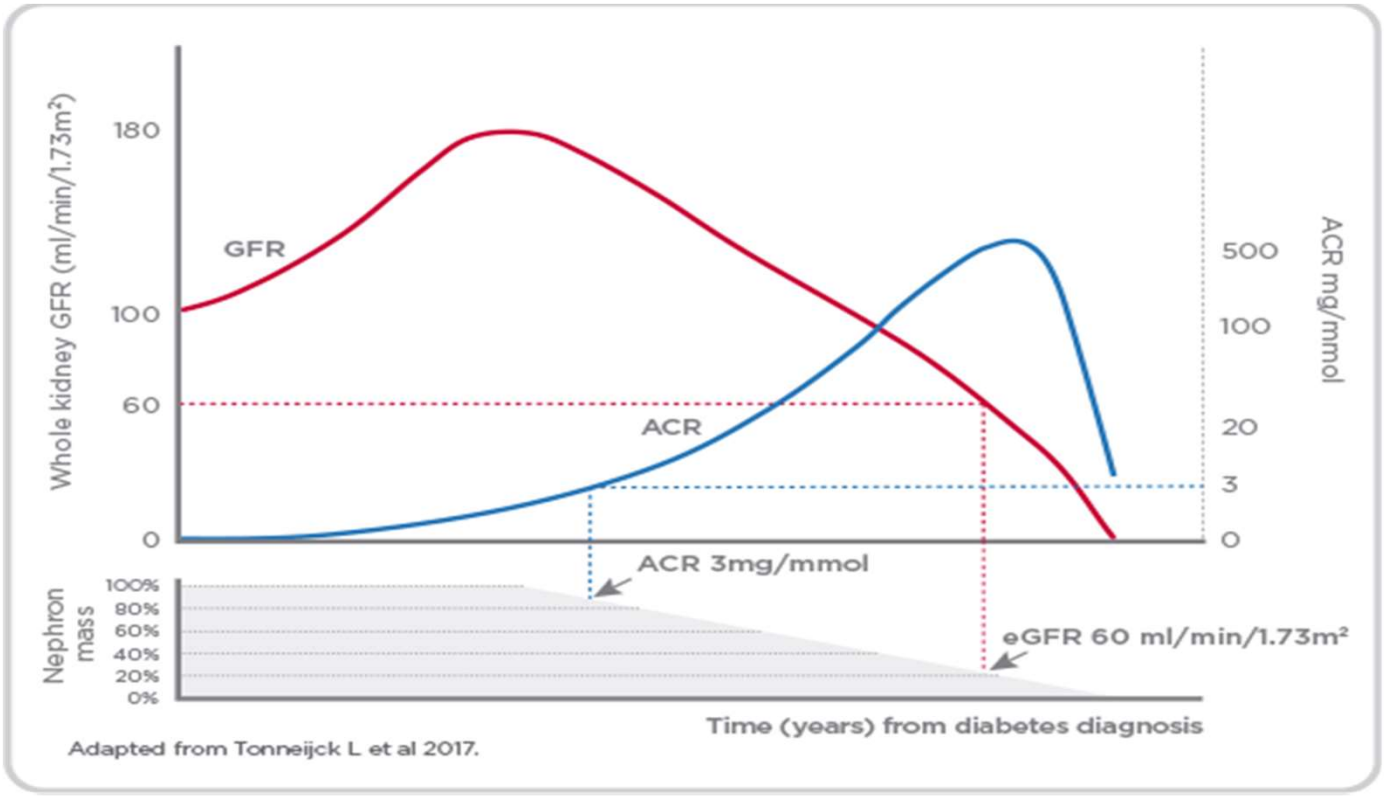
Prognosis of CKD by GFR and Albuminuria Categories: KDIGO 2012

GFR categories (ml/min/ 1.73 m^2) Description and range				Persistent albuminuria categories Description and range		
				A1	A2	A3
				Normal to mildly increased	Moderately increased	Severely increased
				<30 mg/g <3 mg/mmol	30-300 mg/g 3-30 mg/mmol	>300 mg/g >30 mg/mmol
	G1	Normal or high	≥90			
	G2	Mildly decreased	60-89			
	G3a	Mildly to moderately decreased	45-59			
	G3b	Moderately to severely decreased	30-44			
	G4	Severely decreased	15-29			
	G5	Kidney failure	<15			

Green: low risk (if no other markers of kidney disease, no CKD); Yellow: moderately increased risk; Orange: high risk; Red, very high risk.

https://www.nice.org.uk/guidance/ng203

Chronic Kidney Disease: ACR v eGFR



Adapted from Tonneijck L et al 2017.

Chronic Kidney Disease: Diagnosis

At Diagnosis:

- First eGFR <60ml/min re-test in 2 weeks
- Progression: 3 eGFR over 90 days
- Obtain ACR

  2 out of 3 EMUS positive

  UACR x 3 over 3-6months. >3mg/mmol indicates proteinuria

  3-70mg/mol repeat 3 months
- Microalbuminuria <2.5mg/mol in men , >3.5mg/mol in women

Always screen when person free of illness and exclude meat from diet 12 hours before.

https://www.nice.org.uk/guidance/ng203

ACR Collection

- Nationally less than 40% of patients have an ACR
- ‘Any Wee Will Do’
- If test abnormal retest using Early morning sample

Chronic Kidney Disease: Treatment

Renin–angiotensin–aldosterone system antagonist:
A medicine that blocks or inhibits the renin–angiotensin–aldosterone system, including angiotensin-converting enzyme (ACE) inhibitors, angiotensin-receptor blockers (ARBs), direct renin inhibitors and aldosterone antagonists.

- ARB or ACE inhibitor- titrated to highest licensed tolerated dose.
- Monitor eGFR and serum potassium before starting ARB Repeat 1-2 weeks after

https://www.nice.org.uk/guidance/ng203

Chronic Kidney Disease: Other Considerations

CKD Stage 1-3a

- HbA1c U&E's FBC LFT's &cholesterol

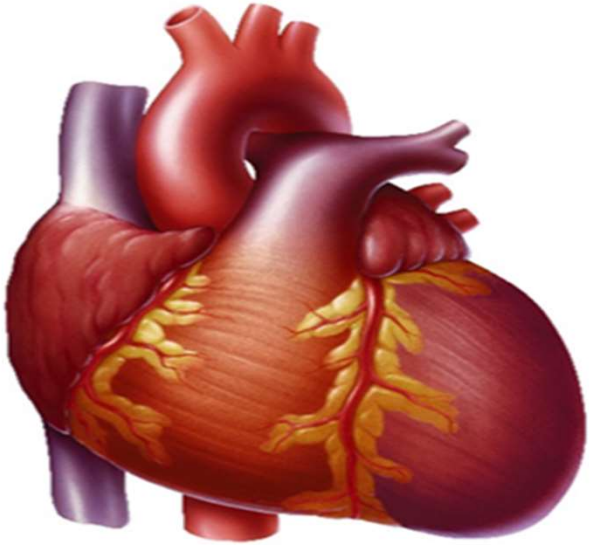
Stages 3b-5

As above +

- Ferritin, Bone Profile, Parathyroid, Hormone, & Vitamin D levels

https://www.nice.org.uk/guidance/ng203

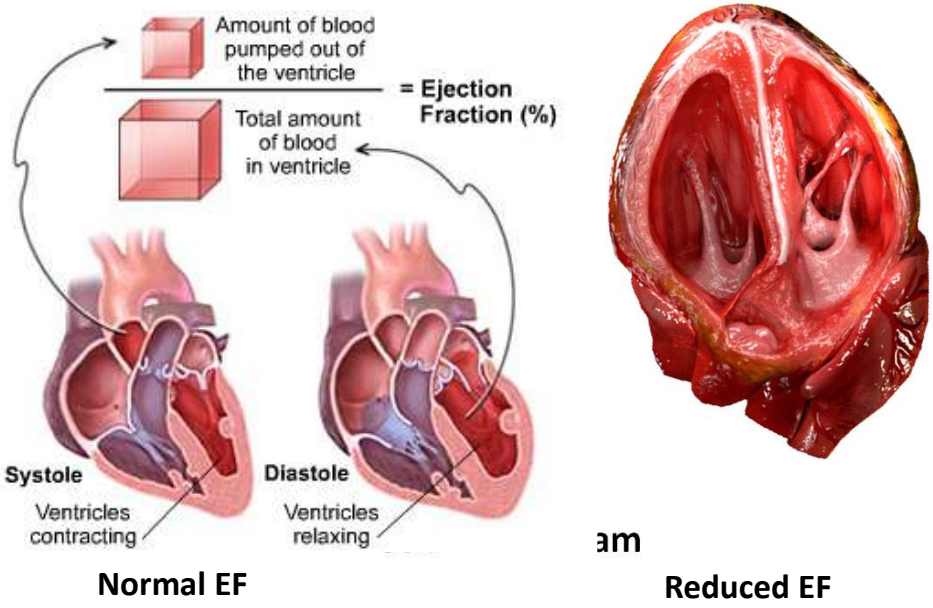
Investigations for Heart Failure



- **NTproBNP < 400ng/L normal**
- **FBC**
- **ELECTROLYTES**
- ECG
- ECHOCARDIOGRAM
- CHEST XRAY

Ejection fraction (EF) is a key criteria in heart failure management

- **EF** is the percentage of blood that is pumped out of the heart during each beat
- A normal EF is ≥50%
- Heart failure with an EF ≤40% is known as **heart failure with reduced ejection fraction** (HFrEF)
- Heart failure in the setting of a normal EF is known as **heart failure with preserved ejection fraction** (HFpEF)



Yancy CW, et al. *Circulation.* 2013;128:e240-e327.

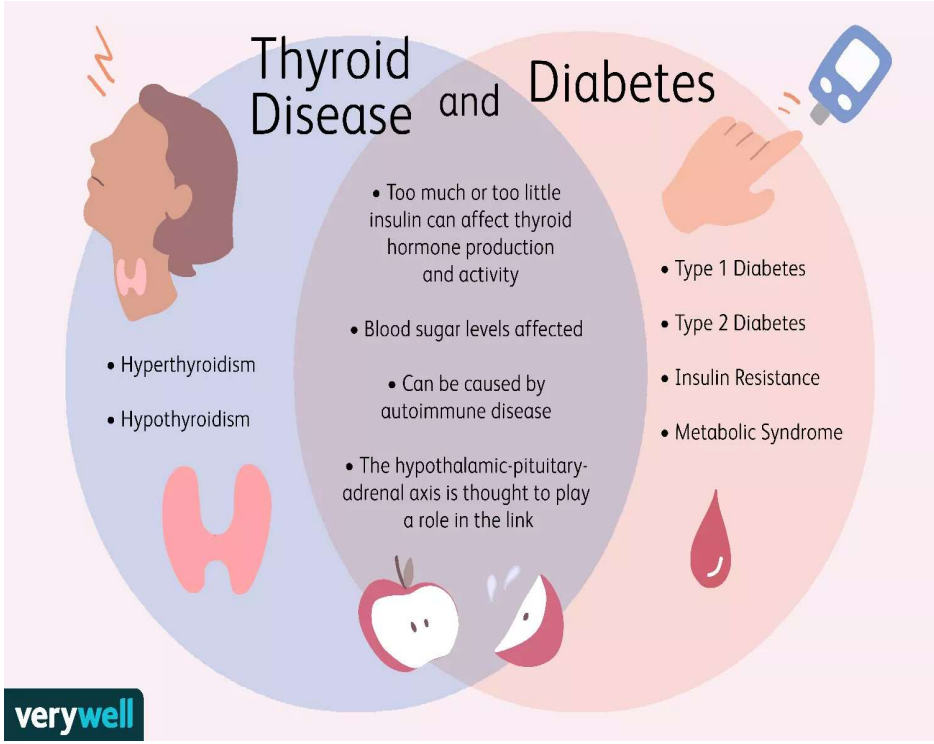
Thyroid

Autoimmune disease.

Thyroid disease can disrupt metabolism, allowing blood glucose levels to rise.

Hyperthyroidism can contribute to insulin resistance.

Hypothyroidism decreases metabolism. When this happens, insulin can linger causing hypoglycemia



Thyroid UK

Pregnancy and fertility in thyroid disorders (btf-thyroid.org)

Thyroid

Reference range:
TSH: 0.38 -5.33 mlU/L
Free T4: 7.9 – 14.4 pmol/L
Free T3: 3.8 – 6.0 pmol/L

TSH	T4	T3	INTERPRETATION
High	Normal	Normal	Mild (subclinical) hypothyroidism
High	Low	Low or normal	Hypothyroidism
Low	Normal	Normal	Mild (subclinical) hyperthyroidism*
Low	High or normal	High or normal	Hyperthyroidism*
Low	Low or normal	Low or normal	Nonthyroidal illness; Rarely hypothyroidism due to pituitary disease

Vitamin B12 Deficiency and Metformin

Increased risk with long duration of metformin use >10years

No consensus regarding routine testing

Test if high likelihood of deficiency:

- Elderly
- Macrocytosis
- Megalobastic anaemia
- Gastric absorption problems
- autoimmune conditions
- Vegan

Test if symptomatic:

- depression
- irritability
- mouth ulcers
- visual and motor disturbances

Vitamin D Deficiency

- Association between low levels of Vit D and insulin resistance
- Maintaining normal release of insulin from beta cells
- Maintaining good beta cell function
- Increased risk of type 2 diabetes
- Long-term deficiency can increase risk of obesity, hypertension

- Vitamin D levels should ideally be between 20-50 ng/ml (50-125 nmol/l)*, with anything below 30 ng/ml considered deficient.