The protocol is a *prescription*. Make sure you understand the patient’s history and the true indication for the study.

This will ensure that the technique you prescribe is the most sensitive for that situation/condition.

If you have uncertainty - ask for help.
How?

-Done in eDH
-Select the optimal protocol from a list
-What must be specified:
  • # and timing of imaging phases
  • type of iv contrast
  • type of oral contrast, route, and duration of oral prep
Things to consider

• Age of patient & radiation risk

• # of prior CT scans. Should an alternative test be considered?

• Is the scan necessary; will it change clinical management?
Essential info to know

1. When the target organ enhances maximally
2. Does the tumor/abnormality you are searching for enhance More or Less avidly than the organ
3. When is the greatest attenuation difference expected between the organ and the lesion
4. What are the phases of imaging
Organs enhance at different rates, and to different peak levels.

Compare the density of the liver & pancreas.

150ml at 5cc/sec

Panc enhances maximally before the liver.

Liver brightest here, but note the pancreas has washed out.

The Phases of Imaging

These images were taken every 10 seconds following iv contrast injection.

- True or early arterial phase
- Late arterial phase
- Portal venous phase

Normal Organ enhancement patterns

- Dependent upon
  1. Contrast type
     Different types have different quantities of iodine:
     Example: 100ml of each:
     Omnipaque 300 = 30,000 mg iodine
     Isovue 370 = 37,000 mg iodine
  2. Total volume injected
  3. Injection rate
Target Organ enhancement

At 5 cc/sec injection rate

Note that slower injection rate results in lower peak enhancement and delayed time to peak enhancement.
Defining the phases of imaging

- **Arterial** – there are 2 arterial phases
  - True (25 sec) - used for CT arteriograms
  - Late (35 sec) - used for hypervascular tumors
- **Portal venous** (60-70 sec)
- **Nephrographic** (90 sec)
- ‘**Delayed**’ (anything after 90 seconds)
Early Arterial phase

Aka “True” arterial phase
~25 sec
Only the arteries are opacified
PV is not yet enhanced
Renal cortex enhances

*CTA, reformatting
Late arterial phase or ‘arterial dominant’ phase
~35 sec
Still arterial phase, but some filling of PV HVs will not yet be opacified, liver not yet maximally enhanced Renal cortex avidly enhances
*Pancreas enhances maximally in this phase
Portal venous phase

~60-70 sec
Portal vein fully opacified
HVs now opacified
*maximal liver parenchymal enhancement occurs during this phase
Nephrographic phase

~90-110 sec

Uniform enhancement of renal cortex and medulla; NO cortico-medullary differentiation

No excretion into collecting systems yet

*Liver, pancreas now starting to wash out & not as bright
How do we time scanning

1. Fixed time delay
2. Test bolus
   - 15-20cc given, then scan the area of interest- look for contrast bolus to arrive, then calculate the time delay needed
3. Automated bolus tracking
   - Place ROI on specific structure (will differ depending on scan type), set HU threshold, start injecting, repetitively scan at level of ROI, scan will be triggered to begin when threshold reached
Sequential images following injection

Threshold 120 HU

ROI in abd aorta

Example of automated bolus tracking

Scanning triggered at this point
Hypovascular Tumors

These tumors enhance less avidly than normal liver.

Scan during PV phase, when liver is highest attenuation so contrast between the hypoenhancing tumor and the liver will be the greatest.

All GI luminal adenocarcinomas:
- Gastric
- Small bowel
- Colon
- Rectal

Breast
Lung NSCLC
Pancreatic adenocarcinoma
Hypervascular Tumors

These tumors enhance earlier and MORE avidly than normal liver.

Scan during the late arterial phase, when the tumor enhancement is maximal and will contrast with the hypoenhancing liver.

**Examples:**

- HCC
- Adenoma
- Focal Nodular hyperplasia
- Ocular melanoma
- Pancreatic neuroendocrine
- Carcinoid tumor
- Pheochromocytoma
- Medullary thyroid
- +/- Renal cell
Protocoling CT scans

1\textsuperscript{st} rotation:
Have an attending or senior resident review ALL protocols

2\textsuperscript{nd} rotation:
Have an attending/resident review ALL protocols you have any uncertainty about.

**If you plan to deviate from what was \textit{ordered}, you MUST run it by an attending (may also require a phone call to the ordering doc)**