



8<sup>th</sup> Nordic Course in Emergency Radiology  
May 8-11, 2023 – Aarhus, Denmark

## Imaging of Drug Smuggling



google.com



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# Nothing to disclose, but:

Thanks to colleagues AUMC, Amsterdam (AMC & VUmc):

- Dr Anje Spijkerboer
- Dr Jan Hein van Waesberghe
- Dr Indra Pieters
- Dr Aukje van Tilborg

Thanks to Dr Hans Nieboer, UZ Brussels

## Cases shown mostly published:

# Br J Radiol. 2014 Apr;87(1036):20130500. Epub 2014 Feb 3, doi: **10.1259/bjr.20130500**

\$ La Radiologica Medica – 2014 Oct 10 epub, doi: **10.1007/s11547-014-0458-0**



# Amsterdam



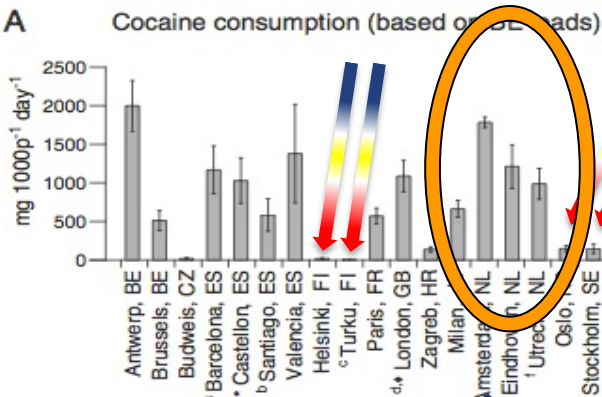


# Sewage sampling...

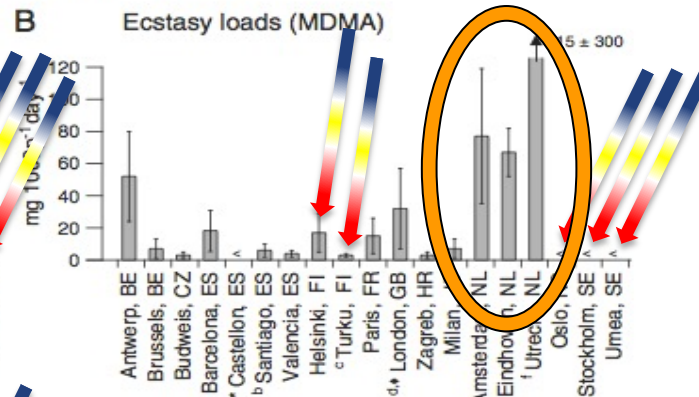
K.V. Thomas et al. / Science of the Total Environment 432 (2012) 432–439

Cocaine

**A** Cocaine consumption (based on SE loads)



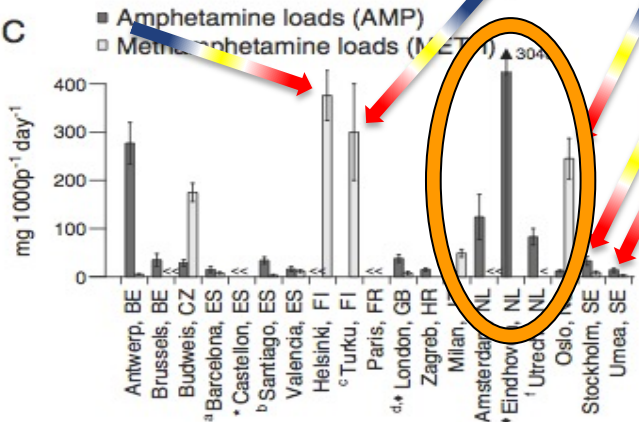
**B** Ecstasy loads (MDMA)



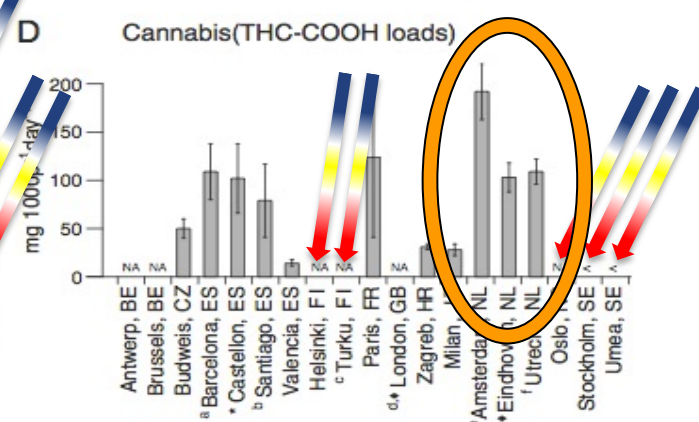
XTC

Speed

**C** Amphetamine loads (AMP)



**D** Cannabis(THC-COOH loads)



Weed

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# Objectives

Getting knowledge of:

- background / scope of problem
- imaging for screening
- imaging clinical complications



# Case 1



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## Case 2



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# Background



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# Background



Vancouver, April 15, 2023

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# Drugs in Numbers

drugs trade 0.6-0.9% of global GDP (US\$ 400 bil)

estimated cocaine use in Europe: 356 kg/day

1/3 has tried illicit drugs

3,6 – 6,9% adult population used last year

overdose = 1 death/hr in Europe

> 1 million pounds / yr seized

UNODC: Financial Flow Report, 2011

Thomas et al. Sci Total Environ 2012;432:432-439

UNODC: World Drug Report, 2013



# Drug trafficking routes



[http://en.wikipedia.org/wiki/Illegal\\_drug\\_trade](http://en.wikipedia.org/wiki/Illegal_drug_trade)

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# Drug smugglers

'Body Packers', aka:

Swallowers, Couriers, Mules, Internal carriers,

Easter Egg, '*Kinder Surprise*'

- ingestion
- rectum/vagina ('body pushing')

('Stuffer' = hastily swallowing when caught)

~ 38% escapes detection

mostly cocaine (~ 80%), heroin and cannabis (~ 20%)

sometimes ATS/MDMA or XTC

money less common



Prabhu et al. Applied Radiol 2008;37(5):26-28  
Dorn et al. J Forensic and Legal Med 2013;20:86-90

# Drug Packets



Fig. 1. Examples of evacuated type 1 solid drug filled packets (A) and type 2 liquid cocaine filled packets (B).

- up to or even > 200 / 2kg
- mean  $70 \pm 20$
- different sizes 2-5 cm
- different materials:
  - latex glove fingers
  - condoms
  - balloons
  - rubber
  - aluminum foil / plastic food wrap / carbon paper
  - mechanical pallets
- average 7-25 grams



Bulakci et al. EJR 2013;82:1248-1254  
Prabhu et al. Applied Radiol 2008;37(5):26-28  
Van Geloven et al. Eur J Surg 168(7):404-409



# Netherlands

## Actueel

### CT-scan in strijd tegen bolletjesslikkers

Geplaatst op: 9-2-2015



Lees verder...

[www.marechausseecontact.nl](http://www.marechausseecontact.nl)

/

**De Koninklijke Marechaussee heeft een nieuwe machine in de strijd tegen bolletjesslikkers. Op Schiphol is eind januari namelijk een fonkelnieuwe Computer Tomogram-scan in gebruik genomen.**

Met het apparaat - beter bekend onder de naam CT-scan - kan nog beter worden vastgesteld of een verdachte wel of niet bolletjes heeft geslikt. De CT-scan maakt dwarsdoorsneden van (een deel) van het lichaam en combineert deze zodat er een driedimensionaal beeld ontstaat. De CT-scan vervangt op termijn het röntgenapparaat.

Als de douane een reiziger heeft aangehouden op verdenking van het slikken van bolletjes met drugs, draagt ze de verdachte over aan het Rechercheteam Drugsbestrijding (RTD) van de Koninklijke Marechaussee op Schiphol.

Since 2015: CT equal dose

Suspect => ~~Xray~~ OR 3x negative stool

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# Imaging – Screening



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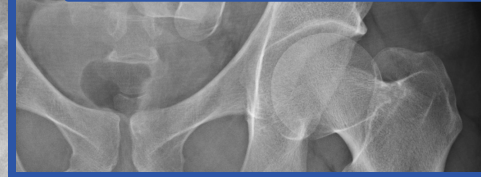
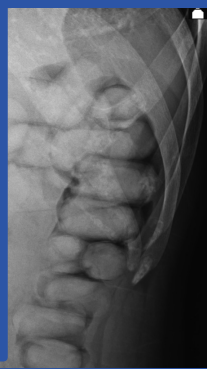


# X-Ray Signs





# X-Ray Signs



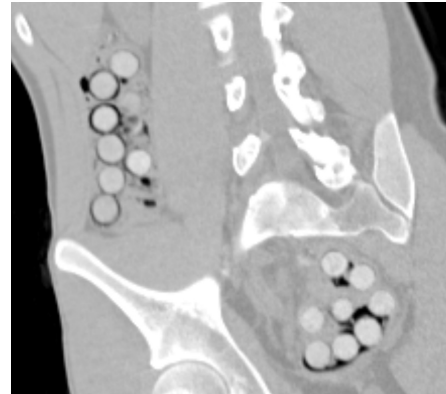


# X-Ray Signs





# CT Signs





# CT – Liquid cocaine



= case 1



# CT – Hypodense Heroin



Courtesy of Dr. Hans Nieboer  
UZ Brussels, Belgium



# Hounsfeld Units of packets

	Case	X-ray density	CT density (HU)
Cocaine	31	Air-stool	-50-285
Methamphetamine	8	Air-stool	-80-110
Heroin	2	More than stool	700 and 960
Liquid cocaine	11	Stool	155-310

Drugs	X-ray density	CT density	Variability X-ray <sup>a</sup>
Heroin	Air	-520 HU	Air-stool
Cocaine	Less than water	-219 HU	Air, less or more than stool
Hashish	More than stool	700 HU	More than stool

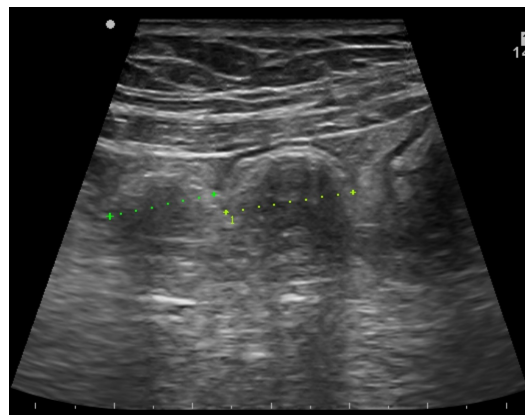
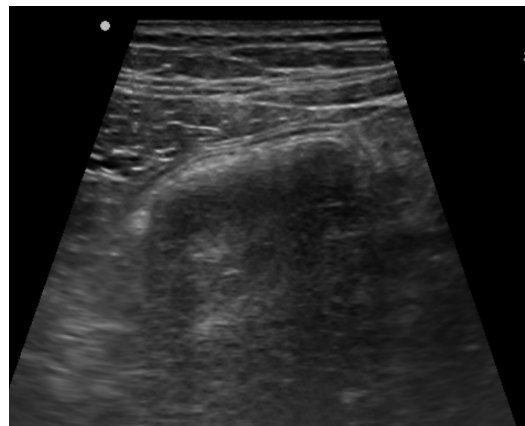
**HU:** *not* reliable

vary with purity, compaction and diluents  
hypo-, iso- or hyperdense

Bulakci et al. EJR 2013;82:1248-1254  
Hergan et al. Eur Radiol 2004;14(4):736-742  
Grimm et al. Int J Legal Med. 2014;128(3):475-82

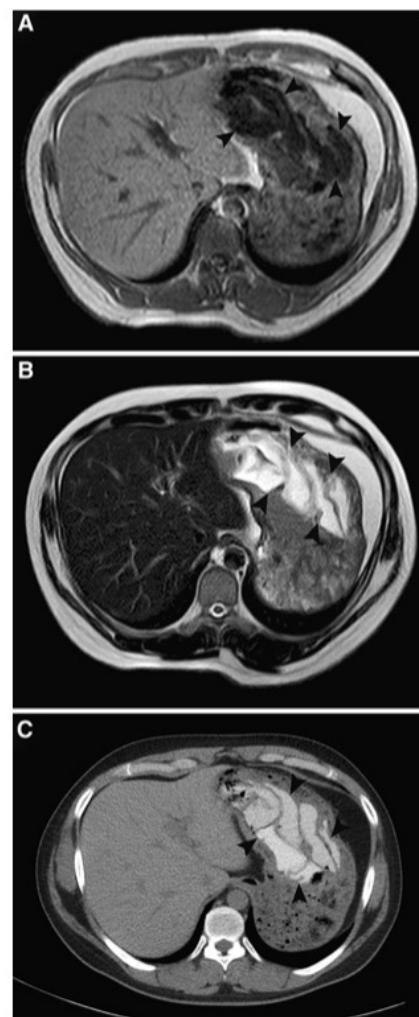


# Ultrasound Signs





# MRI



Bulakci et al. Abdom Imaging 2013;38(3):436-441



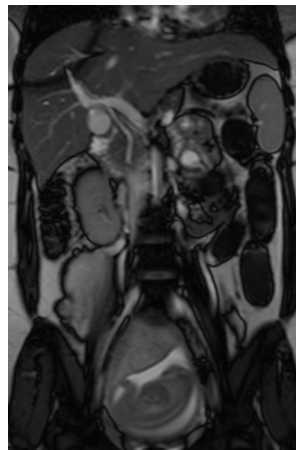


# MRI

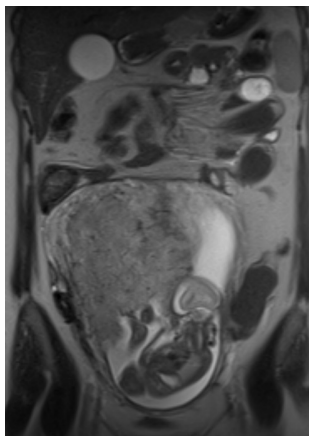
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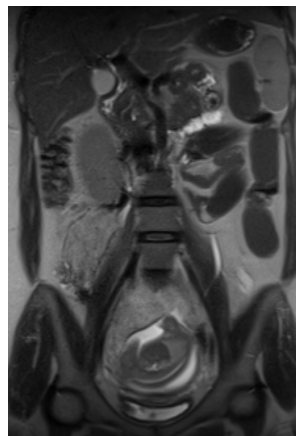
T2 TRUFI



T2 HASTE



T2 HASTE

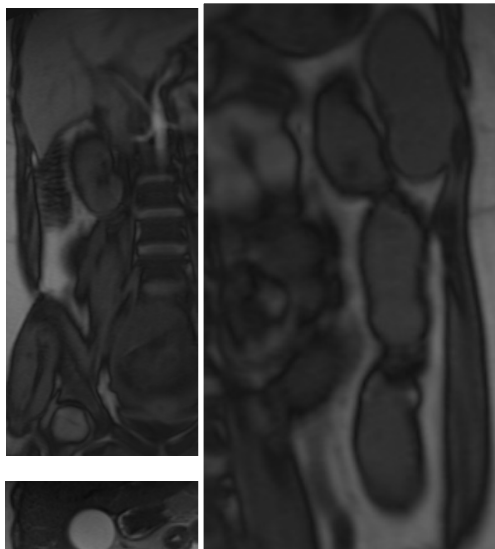


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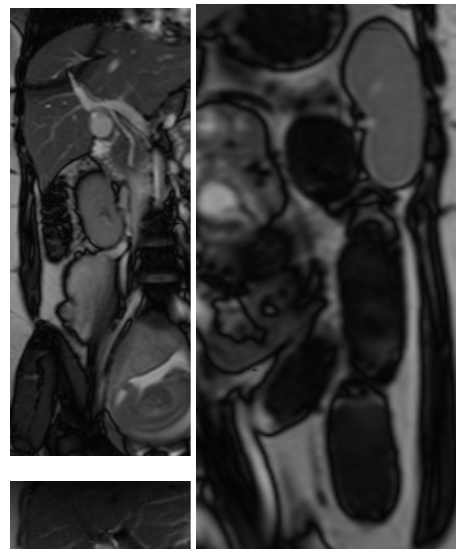


# MRI

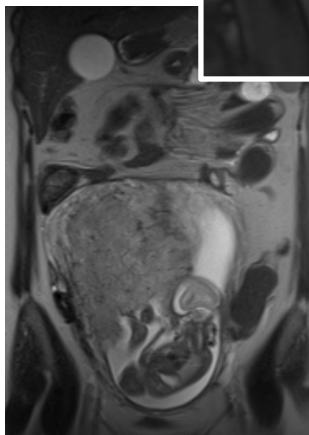
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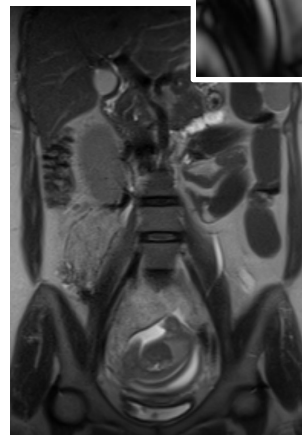
TRUFI



T2 HASTE



T2 HASTE



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# Imaging – Screening

modality	sensitivity	specificity	PPV	NPV	dose
X-ray	28.6-77%	90-100%	74%	97%	1.3-2 mSv
US	accuracy 94%		PPV 97.6%		-
CT	98-100%	100%	100%	62.5%	~ 5-20 mSv
'low dose' CT	100%	100%	-	-	1.2-1.7 mSv 2.23 ± 0.72 mSv
CT – scout	68%	-	100%	89%	1/3 <sup>rd</sup> of CR
MRI	-	-	-	-	-

sensitivity of toxicology:  
~ 50% in asymptomatic  
~ 70% in ruptured packet



# CT – dose reduction

## Screening of Illegal Intracorporeal Containers

(“Body Packing”): Is Abdominal Radiography Sufficiently Accurate? A Comparative Study with Low-Dose CT<sup>1</sup>

Pierre-Alexandre Poletti, MD

**Purpose:** To evaluate the diagnostic performance of abdominal ra-

X-ray: sensitivity 77%, specificity 96%

False negative:

< 12 packets

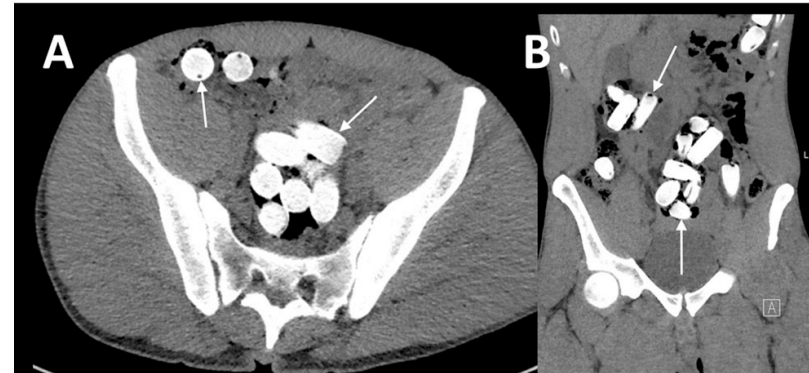
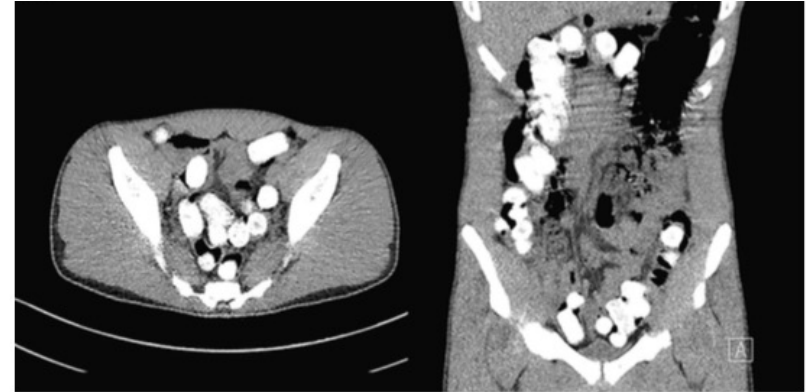
Iso-attenuating packets on CT



# CT – dose reduction

Even only lowering to 100 kVp  
or even 80 kVp:

- Sufficient quality for diagnosis
- Lowers exposure up to 5x



Schulz et al. Clin Radiol (2014) 69:525-530  
Aisa et al. Abdom Imaging (2015) 40:2152–2158  
Aisa et al. Forensic Sci Med Pathol (2017) 13:145-150

# CT – dose reduction

Iterative reconstruction – full model based

Dose at range of **single** X-ray



Exam Description: CT VOOR FEDERALE POLIT

Dose Report					
Series	Type	Scan Range (mm)	CTDIvol (mGy)	DLP (mGy-cm)	Phantom cm
1	Scout	-	-	-	-
2	Helical	140.000-1449.375	0.81	38.34	Body 32
Total Exam DLP:				38.34	

1/1

Courtesy of Dr. Hans Nieboer  
UZ Brussels, Belgium

# CT – dose reduction

RESEARCH

Open Access



## Noise insertion in CT for cocaine body packing: where is the limit of extensive dose reduction?

Joel Aissa<sup>1</sup>, Edwin Bölke<sup>2\*</sup>, Lino M. Sawicki<sup>1</sup>, Elisabeth Appel<sup>1</sup>, Christoph Thomas<sup>1</sup>, Philipp Heusch<sup>1</sup>, Martin Sedlmair<sup>3</sup>, Karl Krzymyk<sup>3</sup>, Patric Kröpil<sup>1,4</sup>, Gerald Antoch<sup>1</sup> and Johannes Boos<sup>1</sup>

**Conclusions:** Our results indicate that dose of abdominal CT for the detection of intracorporeal cocaine body packets can be markedly reduced to up to 5% of the initial dose while still providing sufficient image quality to detect ingested body packets. However, a minimum effective dose of 0.21 mSv (10% of initial dose) seems to be required to properly identify incidental findings.

**Keywords:** CT dose, Image analysis, Drug abuse, Low dose CT

## Lowering dose to 0.2 mSv is appropriate

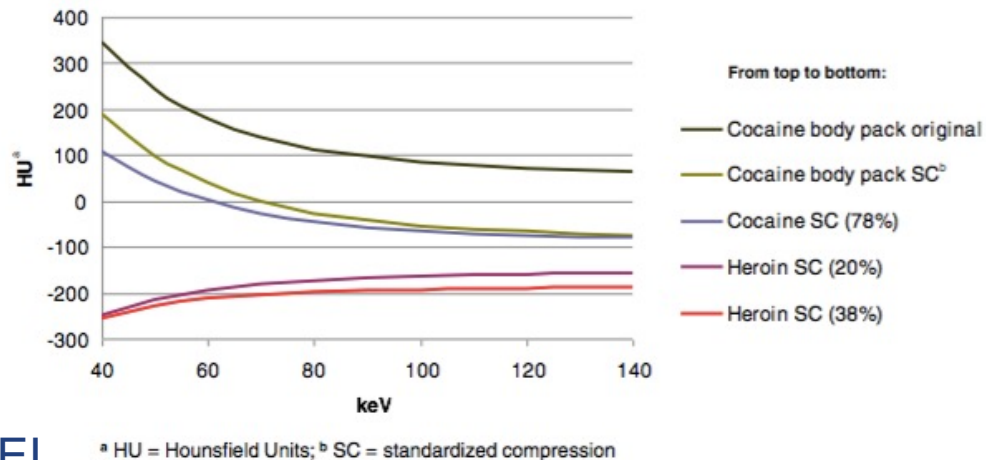
Aisa et al. Eur J Med Res (2018) 23:59



# CT – Dual Energy

## Material analysis:

- Compression ↑ DE-Index
- Pure cocaine and heroin: negative DEI
- Body packets:
  - Heroin - 0.013-0.046
  - Cocaine + 0.029-0.044 -> added Tin



Laberke et al. Forensic Sci Med Pathol (2015) 11:20–28  
Grimm et al. Int J Legal Med. 2014;128(3):475–82



# DECT in vitro – 2020

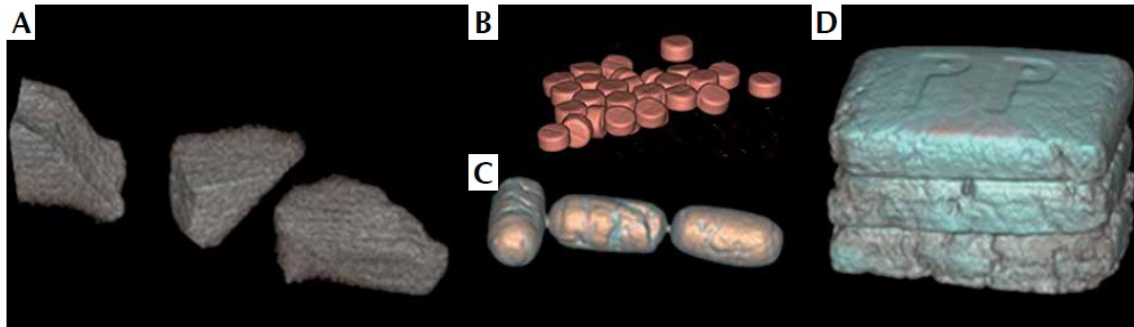


Fig. 1. Example of studied drug samples displayed using volume rendering technique. A – heroin, B – pills of MDMA, C – cocaine, D – cannabis

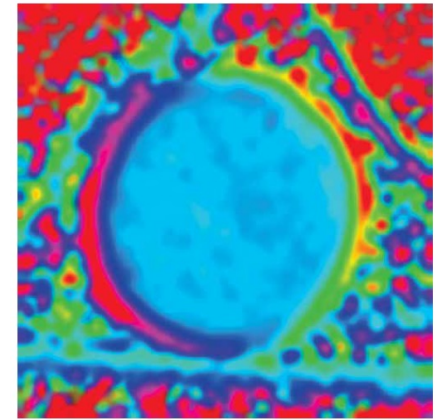


Fig. 2. Dual-energy index mapping (in the axial plane) of a cocaine sample using Image J Software

## Abstract

**Aim of the study:** The objective of this study was to compare the dual-energy behaviour of the main illicit substances as well as their cutting agents in order to be able to differentiate them.

**Material and methods:** Cocaine, heroin, MDMA, and cannabis as well as 3 adulterants, 2 diluents, and water were scanned at 90 kV and then at 140 kV on a single X-ray tube computed tomography (CT) scanner. The data acquired enabled a mapping of the attenuation values to 90 and 140 kVp as well as a resulting dual-energy index (DEI) mapping.

**Results:** Drugs, cocaine, MDMA (pill), and cannabis had a positive DEI (0.014–0.008), while heroin and MDMA (powder) had a negative DEI (–0.016 and –0.013). The DEI of water was –0.01 and that of taurine was –0.018. Adulterants had negative DEI, while diluents had a positive DEI. All DEI were significantly different ( $p < 0.01$ ).

**Conclusions:** Cocaine and heroin can be clearly differentiated using DEI.

**Key words:** dual-energy CT, dual-energy index, illicit drugs, bodypacking.

Boizet et al. Arch Med Sadowej Kryminol  
2020; 70(4):235-241



# Imaging – Complications





# Complications

Journal of Forensic and Legal Medicine 20 (2013) 86–90



Contents lists available at SciVerse ScienceDirect

Journal of Forensic and Legal Medicine

journal homepage: [www.elsevier.com/locate/jflm](http://www.elsevier.com/locate/jflm)



Original communication

## Prevalence and medical risks of body packing in the Amsterdam area

Tina Dorn PhD, Researcher<sup>a,\*</sup>, Manon Ceelen PhD, Researcher<sup>a</sup>,  
Koos J.C. de Keijzer MD, Medical coordinator<sup>b</sup>, Marcel C.A. Buster PhD, Researcher<sup>a</sup>,  
Jan S.K. Luitse MD, Medical director<sup>c</sup>, Edwin Vandewalle MD, Medical coordinator<sup>d</sup>,  
Henk J. Brouwer MSc<sup>e</sup>, Kees Das LL.M., MD, PhD, Forensic physician/head<sup>b</sup>

<sup>a</sup>Department of Epidemiology, Documentation and Health Promotion, Public Health Service Amsterdam, P.O. Box 2200, 1000 CE Amsterdam, The Netherlands

<sup>b</sup>Department of Forensic Medicine, Public Health Service, Amsterdam, The Netherlands

<sup>c</sup>Department of Emergency Medicine, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands

<sup>d</sup>Department of Emergency Medicine, VU University Medical Center, Amsterdam, The Netherlands

<sup>e</sup>Department of General Practice, Division of Clinical Methods & Public Health, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands

May 2007 – March 2008:

707 detainees at airport

30 referred to hospital (4.2 %)

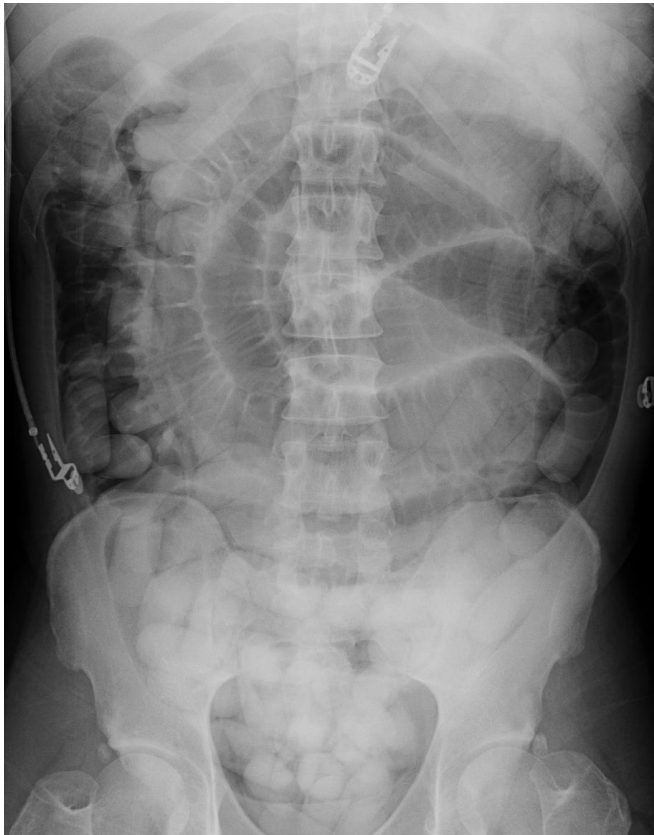
9 needed surgery (1.3 %)

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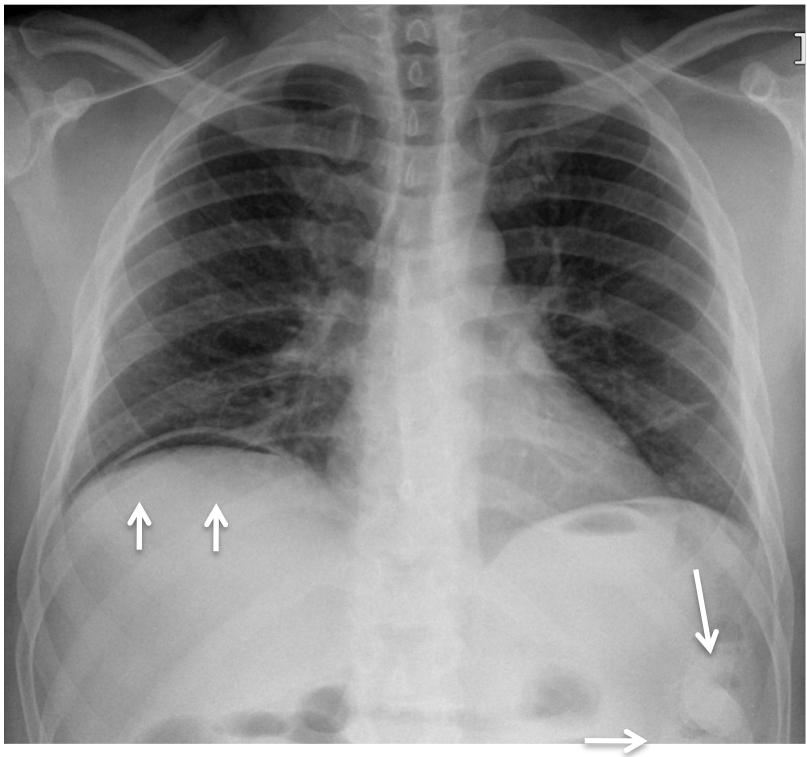


# Complications – Bowel Obstruction



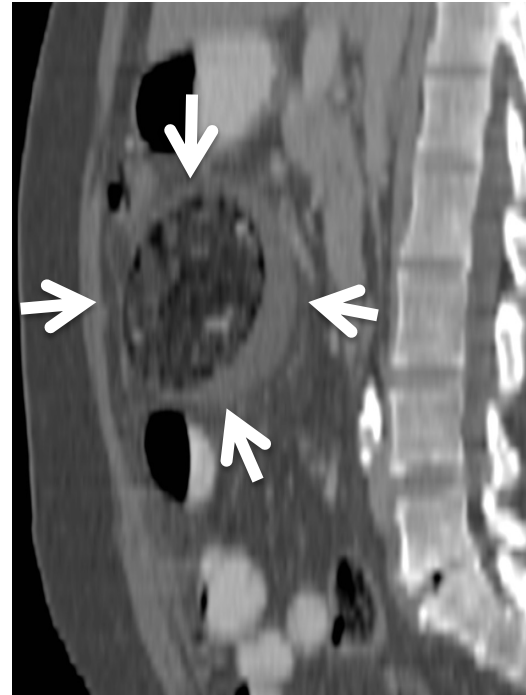
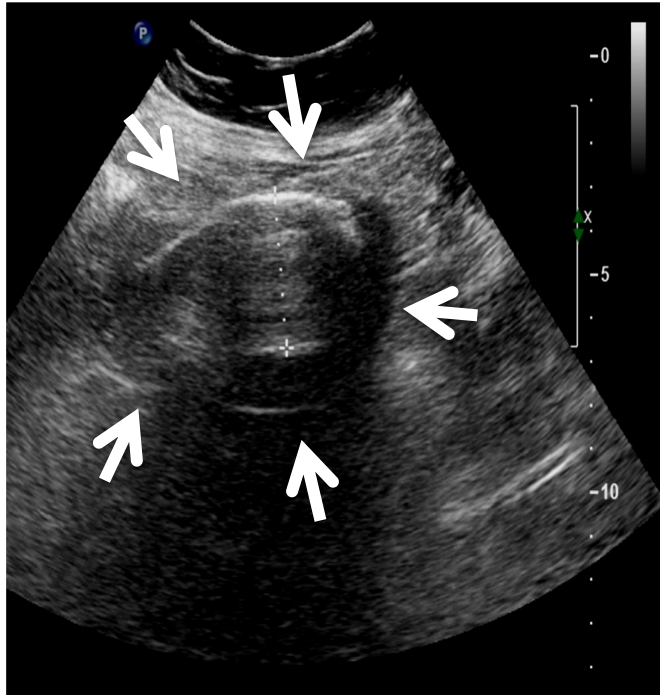


# Complications – Perforation





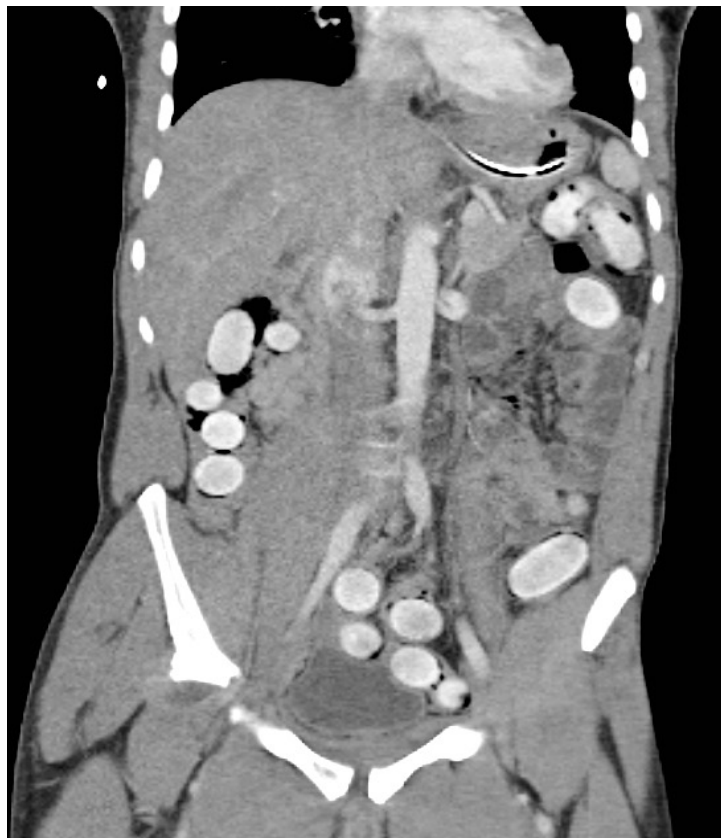
# Complications – Migration



Courtesy of Dr. Anje Spijkerboer, AUMC, Amsterdam



# Complications – Trauma





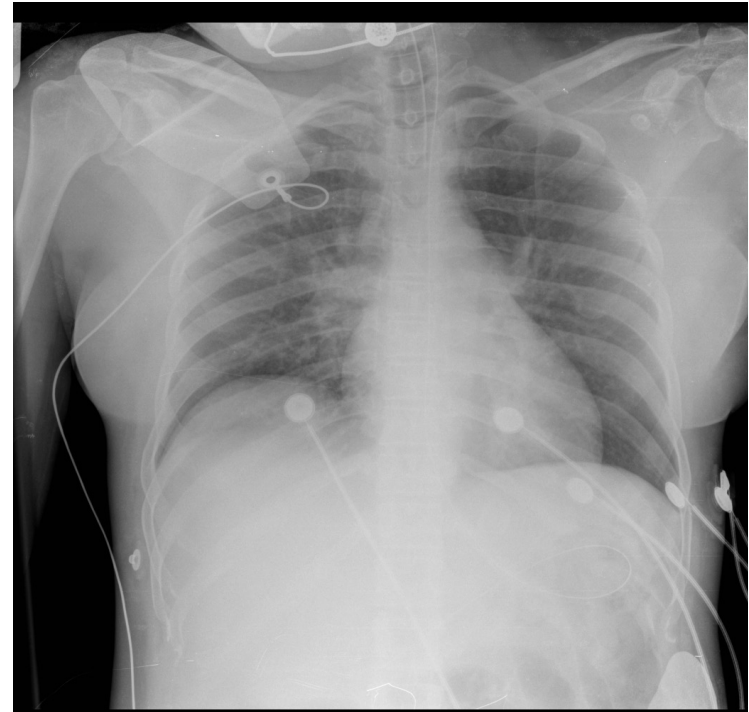
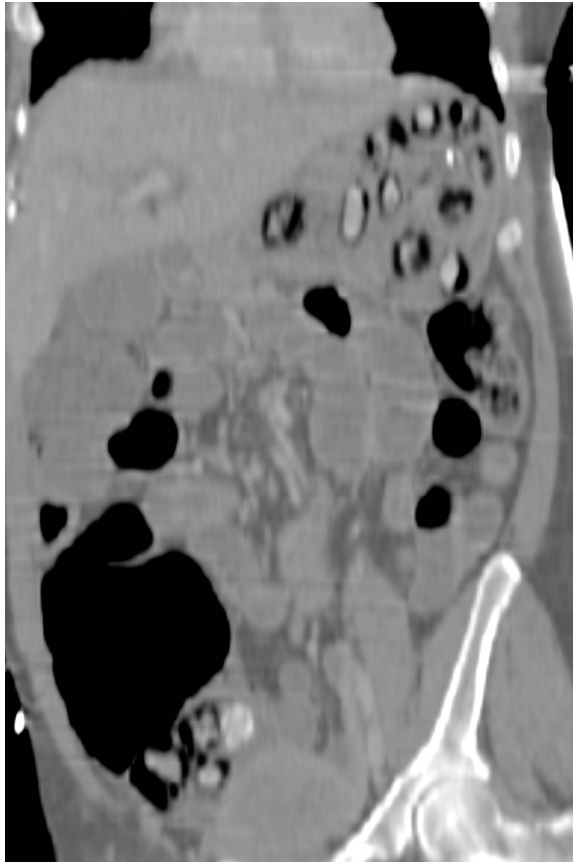
# Complications – Leakage







# Complications – Resuscitation





# Complications – ...itis



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# Complications – Post-op



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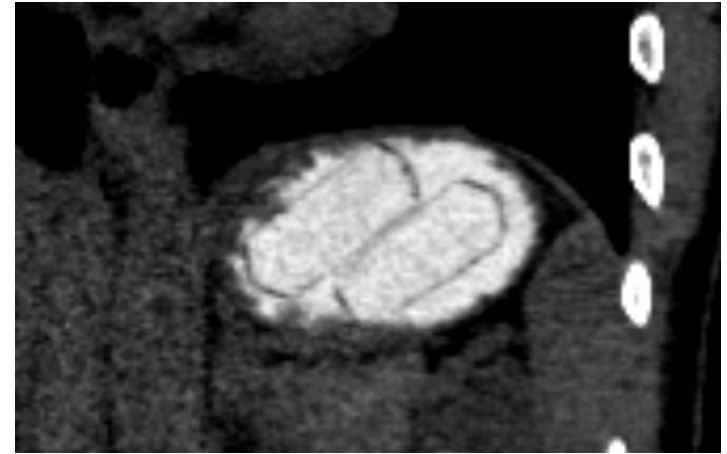
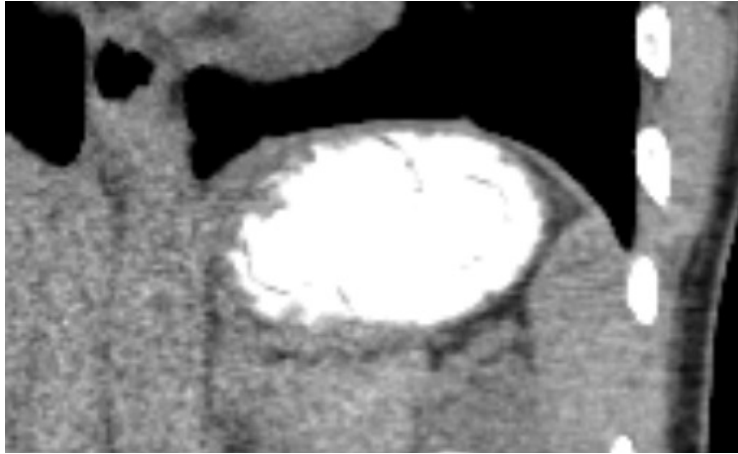


# Imaging – S.o.S.





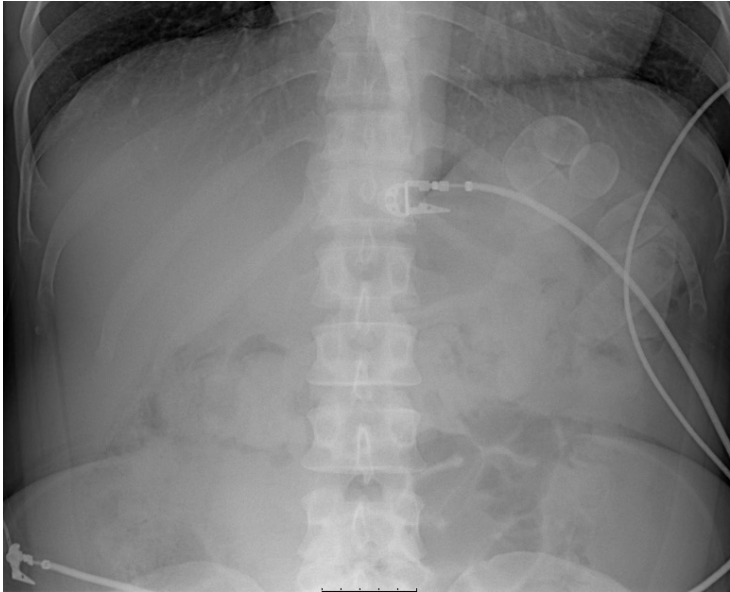
# Imaging – S.o.S.



Shahnazi et al. Clin. Toxicol (2015) 53(7):596-603

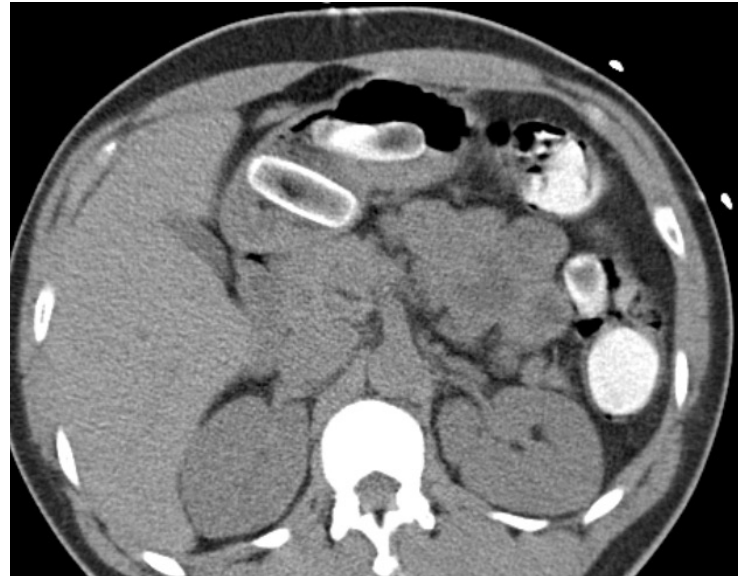


# Imaging – S.o.S.





# Imaging – S.o.S.





# Imaging – S.O.S.



One lonely packet...





# Complications?

**DO CT!** (with IV contrast)

**NO oral / rectal**



# Management

asymptomatic => conservative

symptomatic => surgery

- obstruction
- perforation
- body packers syndrome (=packet rupture)
  
- (delayed passage ?)

**If possible, do CT to guide surgeon**



# Case – day 1



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# Case – day 1



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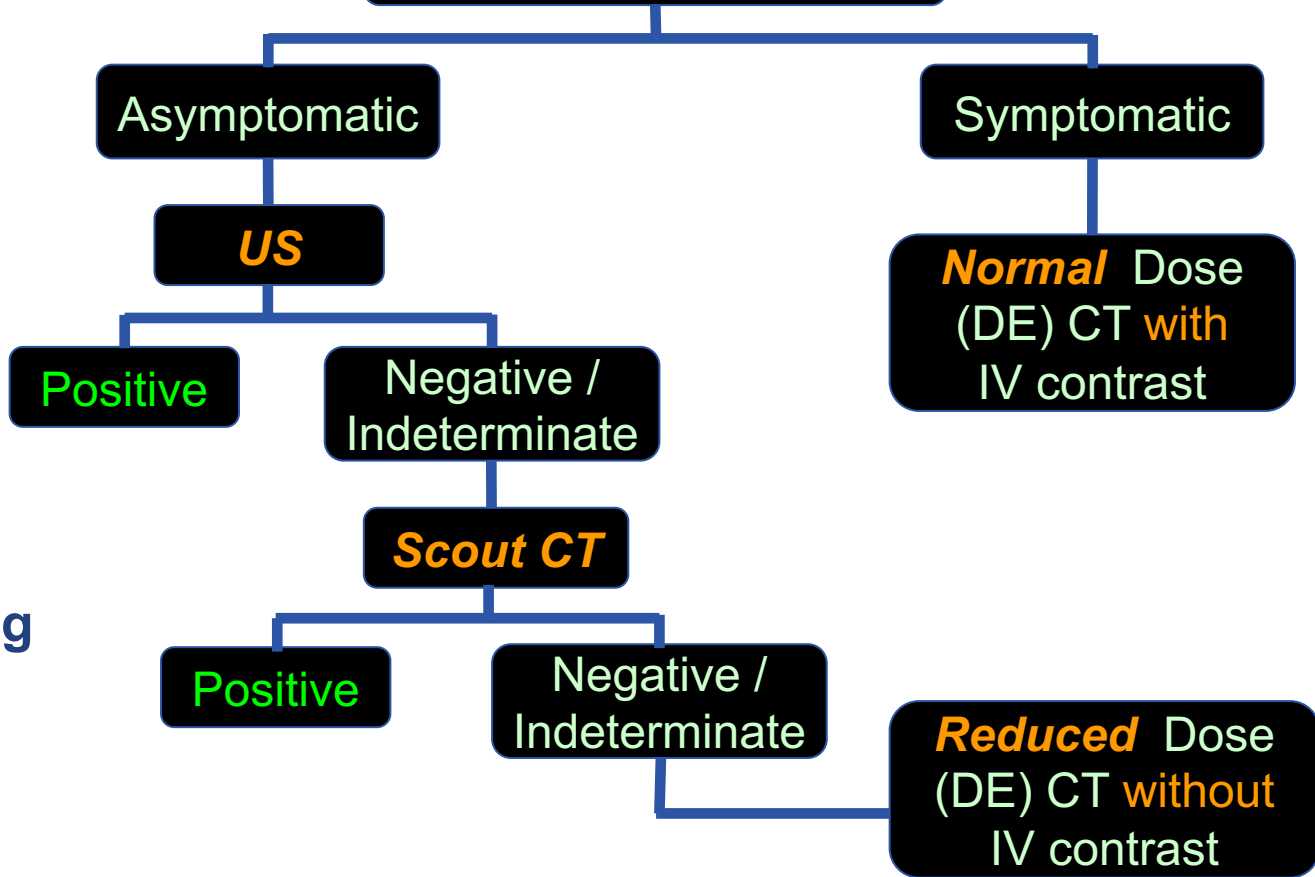
# Case – day 3



2 days post laparotomy



# Suspect body packing



Imaging in drug smuggling



# Take to work

Screening: **CT** >>> X-ray, US, MRI

Hounsfield Units: mean nothing...

DECT: Can differentiate

Complications: **CT** – *no* oral/rectal contrast

Help your EM physician / surgeon!





# Thanks to

Colleagues AUMC, Amsterdam (AMC & VUmc):

- Dr Anje Spijkerboer
- Dr Jan Hein van Waesberghe
- Dr Indra Pieters
- Dr Aukje van Tilborg

Dr Hans Nieboer, UZ Brussels

Cases shown mostly published:

# Br J Radiol. 2014 Apr;87(1036):20130500. Epub 2014 Feb 3, doi: **10.1259/bjr.20130500**

\$ La Radiologica Medica – 2014 Oct 10 epub, doi: **10.1007/s11547-014-0458-0**



# Want to hide money...



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# References

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- [http://en.wikipedia.org/wiki/Illegal\\_drug\\_trade](http://en.wikipedia.org/wiki/Illegal_drug_trade) and [http://en.wikipedia.org/wiki/Drug\\_mules](http://en.wikipedia.org/wiki/Drug_mules)
  
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