

# **Occult pneumothorax in chest trauma- to drain or not to drain ?**

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**A real dilemma  
for the clinician**



# One morning in an Israeli hospital.....



- **A 36-yr old patient is brought by the Mobile ICU to the Trauma Unit, after a motor vehicle accident**
- **List of injuries :**
  - \*fracture of Lt femur**
  - \*Acute abdomen (bleeding ?)**
  - \*Lt chest trauma**
- **At arrival : BP 110/70, HR 128/min**
- **Abdominal US: rupture of spleen, some 750 ml blood in the abdominal cavity**
- **Chest X-ray : -three Lt ribs fractures**
  - Lt chest contusion**



# A laparotomy is decided

- The patient gets i-v fluids
- An urinary catheter is inserted
- A decision: an abdominal CT on the way from the ED to the operating room
- The patient is accompanied on his way by a senior resident in anesthesia



The diagnosis on the abdominal CT:

**Lt anterior pneumothorax**

**So, the question: to drain or not to drain ?!**

# What kind of pneumothorax (PN) is this one ?

**This is an**

**OCCULT  
PNEUMOTHORAX  
(OPN)**

**This is not:**

- **Missed PN**
- **Secondary PN**
- **Residual PN**
- **Delayed PN**

**Definition: Occult pneumothorax (OPN) is that PN detected on CT scan or ultrasound, BUT not on (previous) a routine chest X-ray**





**So, our patient has an occult pneumothorax (OPN). So what ?!**

**Why to drain ?**

**For the anesthesiologist, the danger of TENSION PNEUMOTHORAX during mechanical ventilation is clear**

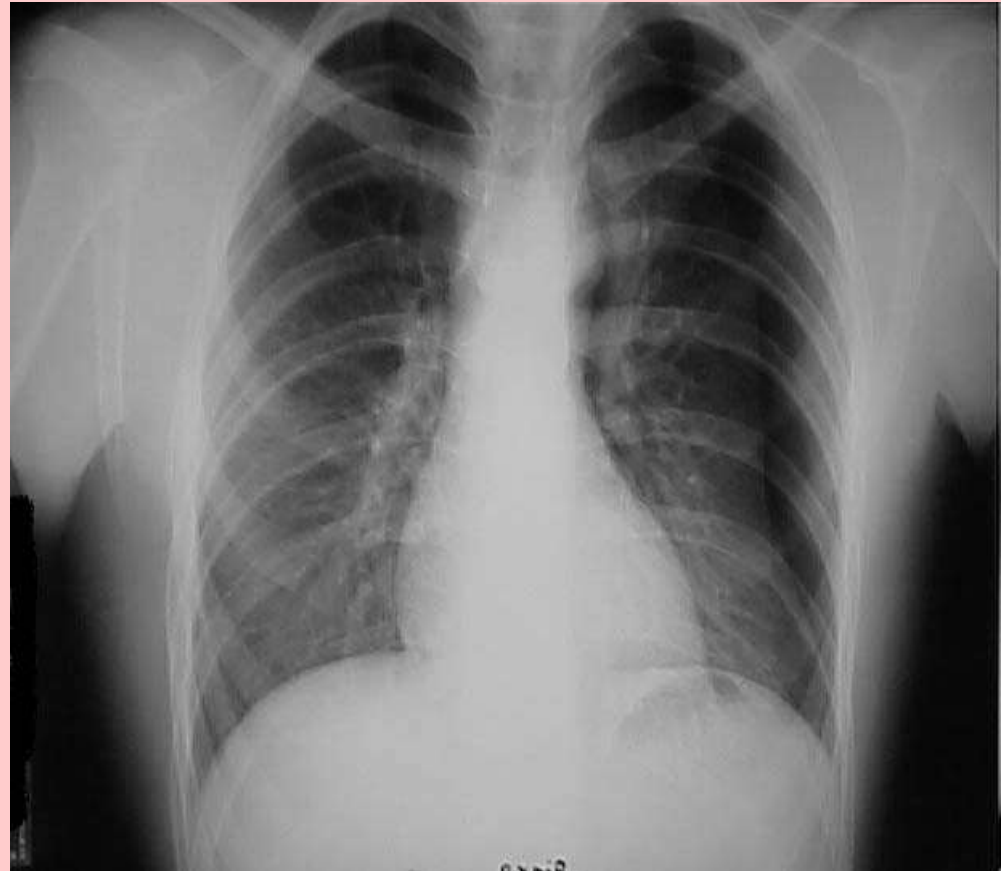
**50% of radiooccult cases of PN yield tension pneumothorax**

***Tocin IM et al Am J Roentgenol 1985;144:901***

# **Incidence of OPN in chest trauma**

# Chest trauma....

- 30% of all trauma victims
- 20-25% of all trauma deaths
- In 70% of cases- blunt trauma is the major cause of chest trauma
- 40% of all **blunt** chest trauma and 20% of all **penetrating** chest trauma develop a pneumothorax
- 5% of all trauma patients



# Occult pneumothorax ?! So what !!!

The detrimental effects of a PN occur when its size causes significant atelectasis and prevents full expansion of the lung

And then.....

- Decreased lung capacity
- Anatomic shunt
- Hypoventilation
- Q/S mismatching
- Reduced cardiac output

**OBSTRUCTIVE SHOCK !**



**Tension  
pneumothorax**

# What is your opinion?

How often is an OPN eventually diagnosed (of all PN):

- \*2-3%
- \*0.2-0.3%
- \*12%
- \*2-20%
- \*up to 70%



# So, OPN is dangerous and not so rare.....

2-12% of all PN

Most publications agree with 5%

And up to 72% in some series

*Omar RH J Trauma Manag and Outcomes 2010;4:12*

55% in the last report of Ball et al

*Amer J Surg 2005;189:541*

**OPN is the most unrecognized diagnosis on the Chest X ray  
(Hehir ,1990)**

# Why do we miss OPN on a regular (A-P) chest x ray ?

- **Supine x ray does not uncover small amounts of air in the pleural cavity**
- **Suboptimal quality of x ray**
- **Chest x ray is done too soon**
- **Chest x ray is attempting to measure a THREE-DIMENSIONAL volume of air in only two dimensions**
- **The amount of air which can be detected (on a supine A-P chest x ray) on cadaver: 200-400 ml**
- **X ray seen only seldom by a radiologist**

**Ball (*Injury* 2009;40:44)**

***Incidence of OPN as high as 76% (!!!) when x-rays are interpreted by trauma team***

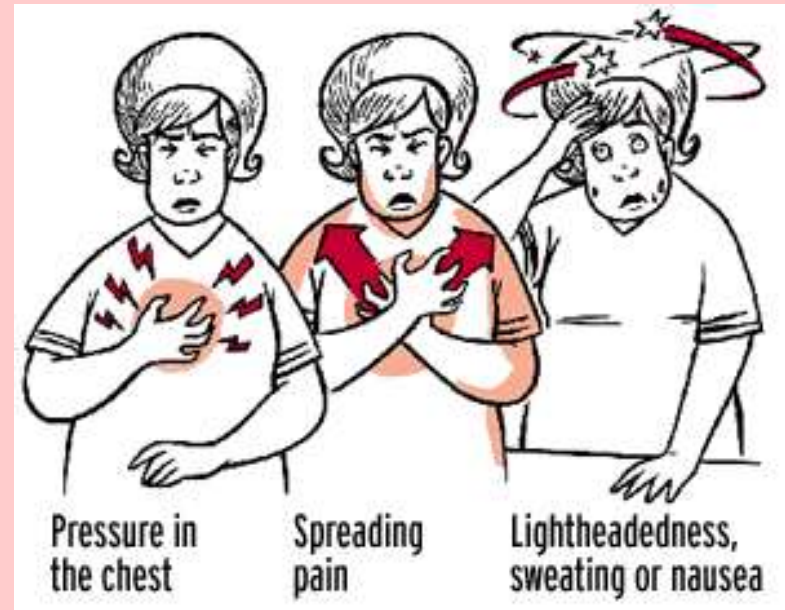




**If this is the situation, can we  
improve the percentage of  
correct and early diagnosis of  
OPN?**

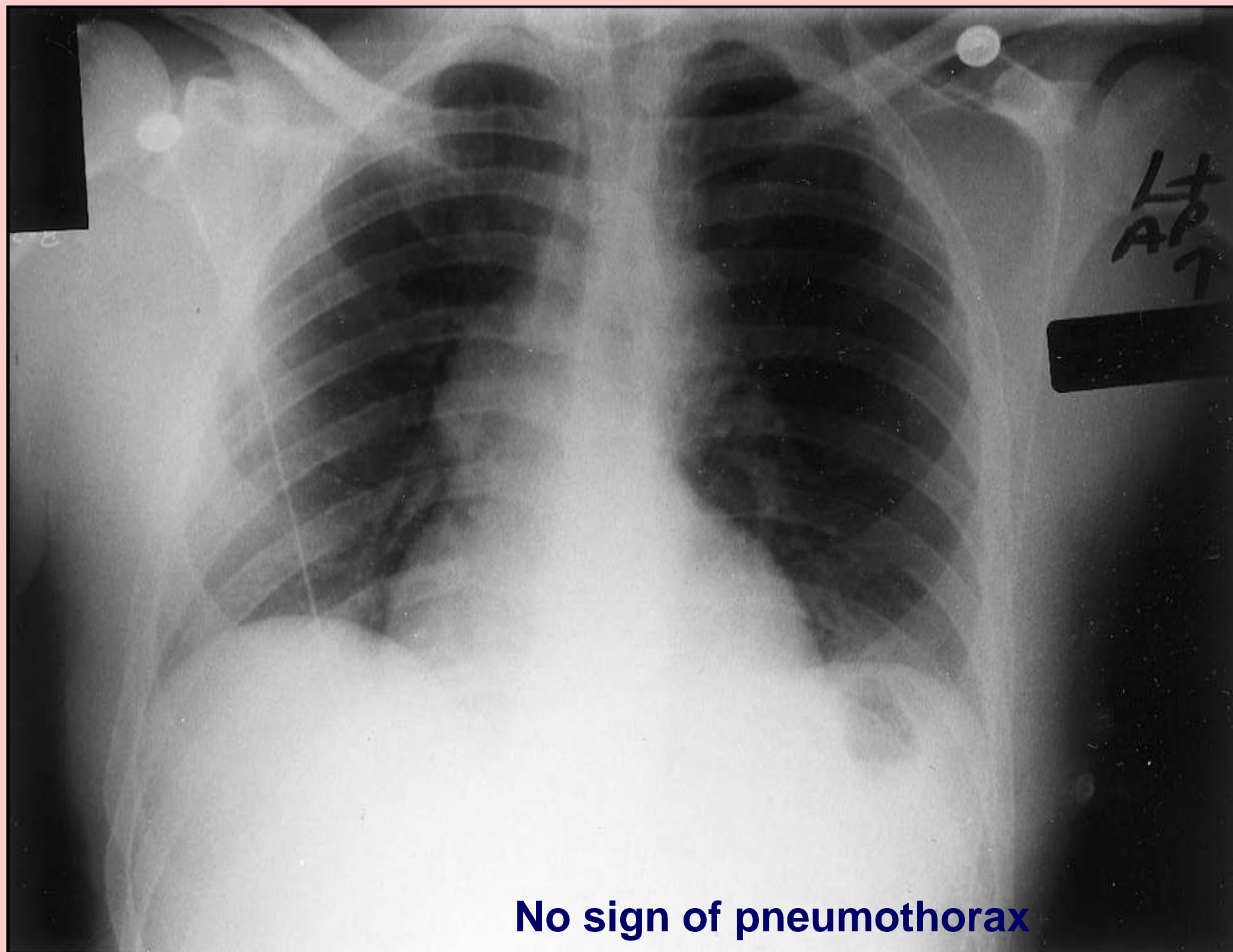
# First of all, the clinical signs

- **Worsening clinical condition**  
(dyspnea, cyanosis)
- **Worsening blood gases values**
- **Presence of rib fractures**
- **Subcutaneous emphysema!!!! (odd ratio 5.47!!)**



**And what about CT scan ?**

**CT scan picks up those OPN  
which are too small or too  
shallow to be diagnosed by a  
regular chest x ray**



**No sign of pneumothorax**

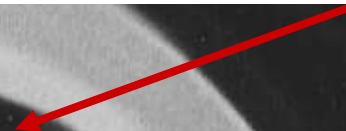
SN I192.3

Im:38 +C

DFOV 36.0cm

DETL

**Anteromedial PN**



R

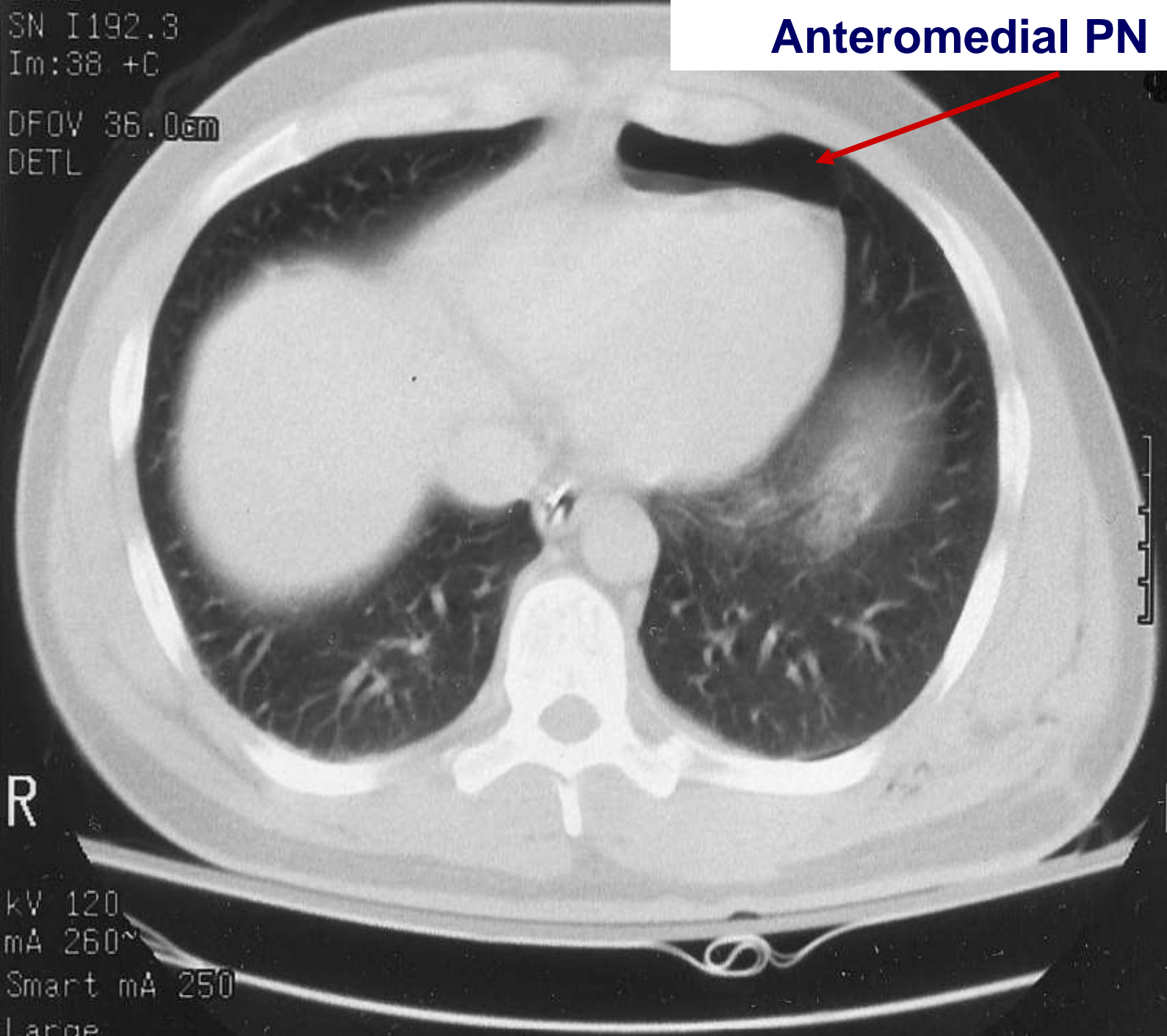
L

kV 120

mA 260~

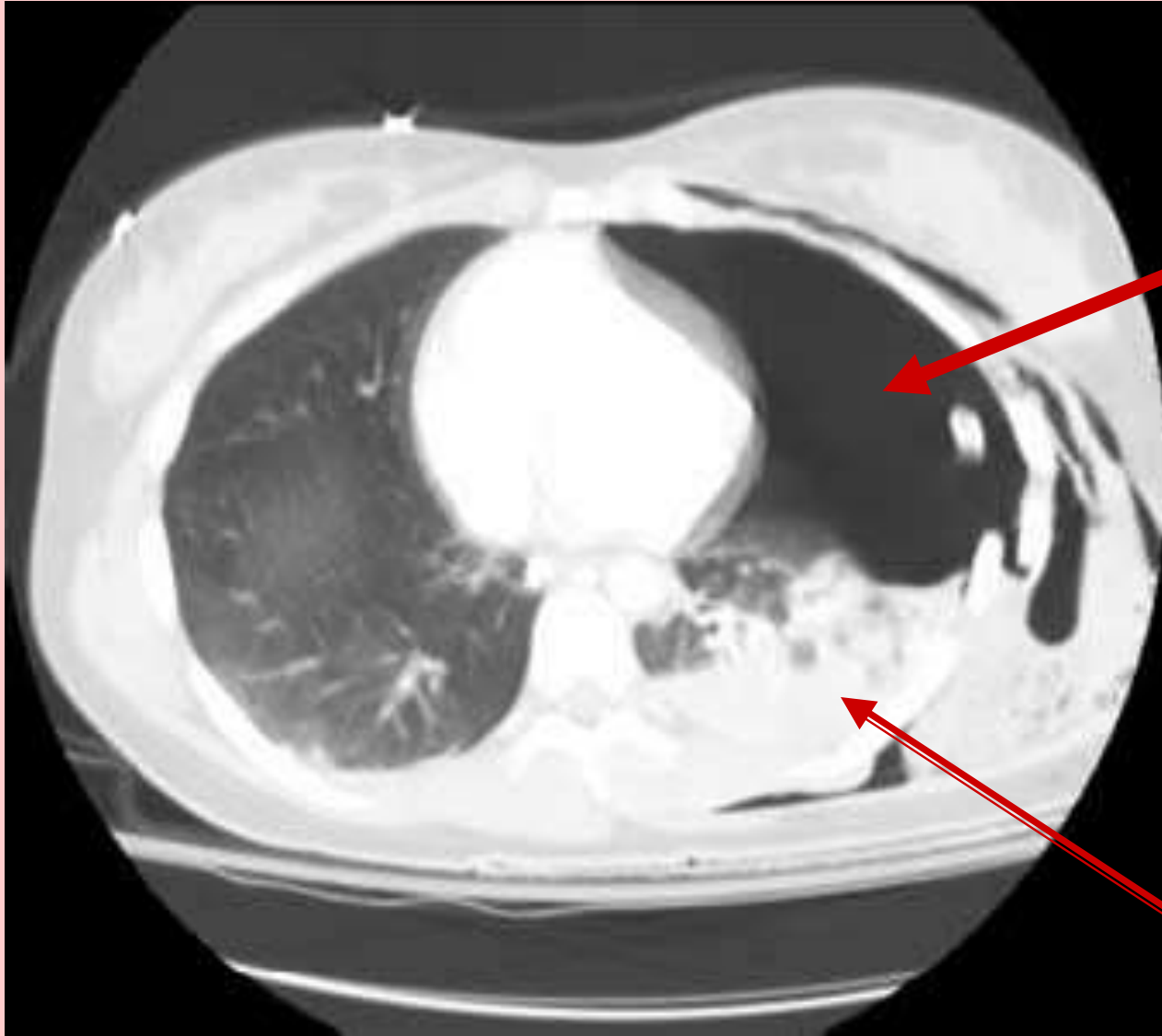
Smart mA 250

Large





**Pleural opacity due to pleural fluid and pulmonary contusion**



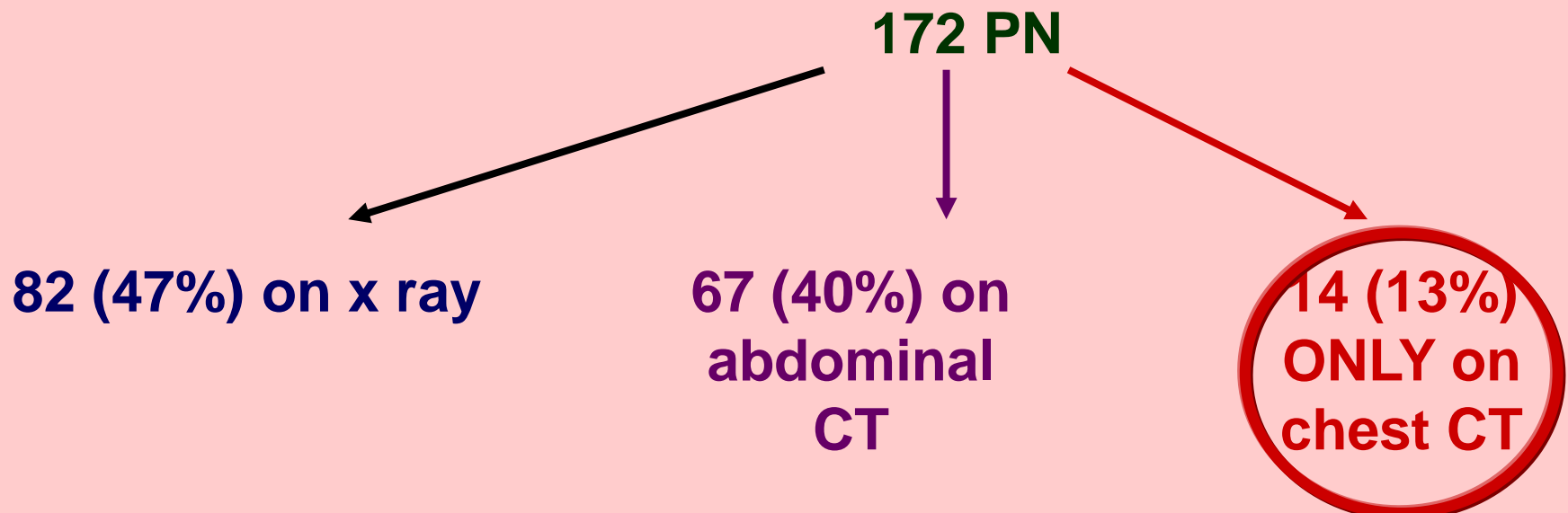
**Large occult  
PN on the  
left thorax**

**Pleural  
effusion  
(seen on X  
ray)**

# *Hill et al. The American Surgeon* *1999;65:254*

**Four years of study (1993-1997), in  
Roanoke, Virginia, USA**

**3121 trauma patients**





**This would be the first  
conclusion: even the  
abdominal CT would leave a  
certain percentage of OPN  
undiagnosed !!**

# And what about chest ultrasound (US) ?

*Lichtenstein DA et al. CCM 2005; 33:1231*

## *Ultrasound in OPN*

*Three US signs were investigated:*

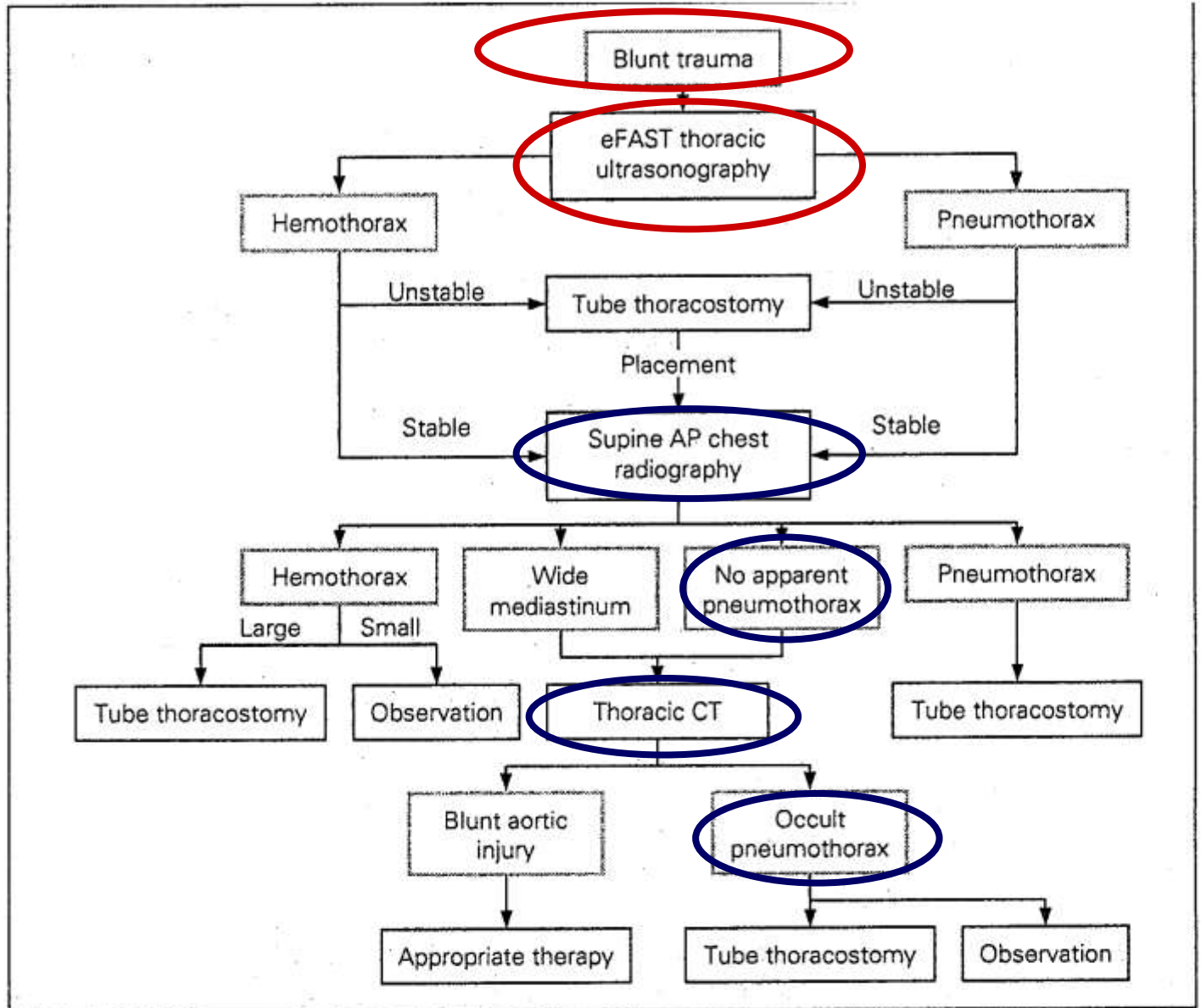
- *Lung sliding : pleural line visibly moves with inspiration (NORMAL !)*
- *Two artifacts (ABNORMAL):*
  - \*A line-an horizontal line between the ribs shadows*
  - \*B line- a vertical line which moves with the lung sliding*

# Ultrasound for OPN

## *Omar, 2010*

- Does not need patient transport
- No high dose of radiation
- Sensitivity 92-100% (*Crit Care Med 2005;33:1231*)
- Can be easily learned and used by various members of the trauma team
- Can help positioning the chest tubes
- Pleural adhesions and emphysematous bullae could represent potential pitfalls

**As per today, US evaluation of the thorax in chest trauma should be performed during the PRIMARY survey !!**



**Fig. 1:** Diagnostic algorithm for blunt thoracic trauma. AP = anteroposterior; CT = computed tomography; eFAST = extended focused assessment with sonography for trauma.

# **Interesting data from 2008**

***(Soldati G et al. Chest 2008;133:204)***

A 18-month prospective study  
**218 hemithoraxes-109 patients**

**25 pneumothorax detected by CT**



**13 (52%) detected  
by A-P chest x ray**

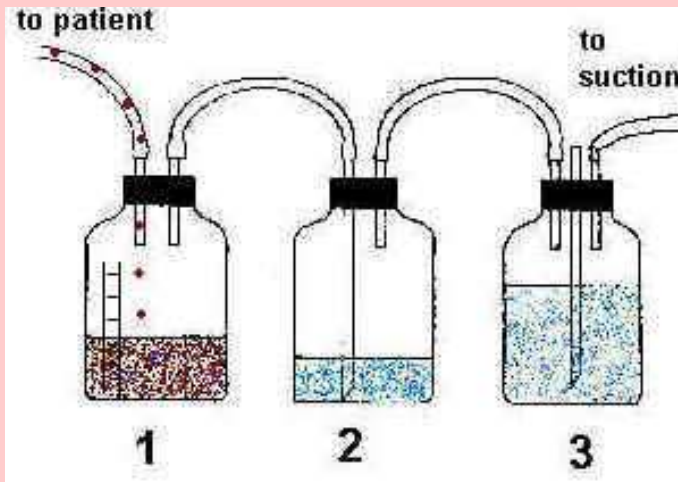
**23 (92%) detected  
by Ultrasound (US)  
(+one false positive)**

**In 20 out of 25 cases- a perfect agreement on the  
extension of the pneumothorax between CT and US**  
**No chest x ray could give quantitative results!!**

# And now the crucial point !

**To drain or  
not to drain  
???**

And to simplify the question:  
To drain or not to drain a patient who is supposed to be ventilated (ICU, general anesthesia ) ?



**And this is the second question  
for the audience:**

**How many of you  
would drain any  
occult PN before  
mechanical  
ventilation?**



# The classical approach

**Clinical and instrumental observation  
+ O2 administration**

**No deterioration**



**No intervention**

**Deterioration?**

- **Simple aspiration with a catheter**
- **Chest tube insertion**
- **Thoracoscopy**



**But in fact we are speaking  
about.....**

**The  
danger of  
tension  
PN**

**VS**

**Negative  
effects of  
pleural  
drainage**

# **In more than 20% of drained patients a complication occurs...**

- **Pain**
- **Vascular injury**
- **Improper positioning of the drain**
- **Inadvertent tube removal**
- **Longer hospital stay**
- **Empiema**
- **Pneumonia**

**But it would  
be  
interesting  
to see what  
the  
literature  
says....**



Reference	Treatment	Outcome	Recommandations
<b>Garramone, Surg Gynec Obst 1991;173:257</b>	<b>27 pts, observation</b>	<b>10 failed</b>	<b>Prophylactic chest tube BEFORE general anesthesia</b>
<b>Collins, Am Surg 1992;58:743</b>	<b>24 pts: 11-tube, 13-observed</b>	<b>1 intercostal injury 2 failed</b>	<b>Observation safe, even with mechanical ventilation</b>
<b>Wolfman, AJR 1998;171:1317</b>	<b>44 pts: 20-tube, 24 observed</b>	<b>1 tension PN</b>	<b>Small PN may not require chest tube</b>
<b>Hill, Am Surg 1999;65:254</b>	<b>29 pts: 27 observed, 2 tube for GA</b>	<b>5 needed chest tube</b>	<b>GA and IPPV demand chest tube</b>
<b>Enderson, J Trauma 1993;35:726</b>	<b>40 pts: 19-tube, 21-observed</b>	<b>3 tension PN</b>	<b>Chest tube needed for mechanical ventilation</b>
<b>Brasel, J Trauma 1999;46:987</b>	<b>39 pts: 18-tube, 21-observed</b>	<b>No adverse effects</b>	<b>Observation is safe</b>

# Why the controversy ?



- **Different ventilatory management (IMV, pressure support, etc)**
- **The modern approach of limiting peak inspiratory pressure**
- **Time can influence, since PN volume decreases each day by:**
  - \*1.25% if FiO<sub>2</sub> is 21%**
  - \*5-8% if FiO<sub>2</sub> is 1**

**(absorption phenomena leading to spontaneous resolution)**

# Nevertheless, there are some guidelines

**1997, American  
College of  
Surgeons  
Committee of  
Trauma**

*(Ball CG et al. Can J Surg  
2003;46:373)*

**“General anesthesia  
or positive pressure  
ventilation should  
NEVER BE  
ADMINISTERED  
without a chest tube  
being placed in any  
patient who has  
sustained a  
traumatic PN or is at  
risk for an expected  
PN”**

# And now the surprise!!!

**The last four papers:**

**\*Yadav K 2010**

**\*Mahmoud J 2013**

**\*Mahmoud J 2015**

**\*Zhang M 2016**

**All say the same thing!!!**

**\*No compulsory indication for drainage, even in case of need for mechanical ventilation**

**\*In all papers both groups-drained and not drained-were homogenous, but the rate of complications was higher in that one drained!!**

**\*The only special prescription is to make sure that the medical team possesses all the means for draining on the spot in case of complications**



# This one did not drain!!!!!!

*(Wilson H et al. 2009)*

- Nova Scotia Trauma Register  
1994-2003

**1881 blunt chest trauma cases**

**307 pneumothorax cases**

**68 OPT**

**35 drained**

**33 not drained**

<b>29</b>	<b>mech. ventil</b>	<b>16</b>
<b>25</b>	<b>ISS</b>	<b>22</b>
<b>17</b>	<b>length of stay (days)</b>	<b>10</b>
<b>0</b>	<b>tension pneumothorax</b>	<b>0</b>

**Conclusion: there is no obligation to drain a OPT.**

**Non-draining policy may contribute to a shorter length of stay in hospital!**

**So, you did  
not drain!  
And what?!**



# *Hill, Amer Surg 1999;65:254*

- The decision not to drain is to be taken with the full knowledge of the anesthesiologist in charge with the patient
- It is compulsory to prepare the placement of a chest tube if respiratory compromise occurred
- Long orthopedic and neurosurgical procedures might indicate a prophylactic chest insertion
- The surgeon- anesthesiologist **COOPERATION** during the procedure is **CRUCIAL** for preventing disaster

**The good  
news:  
there are  
some  
points of  
consensus  
!**



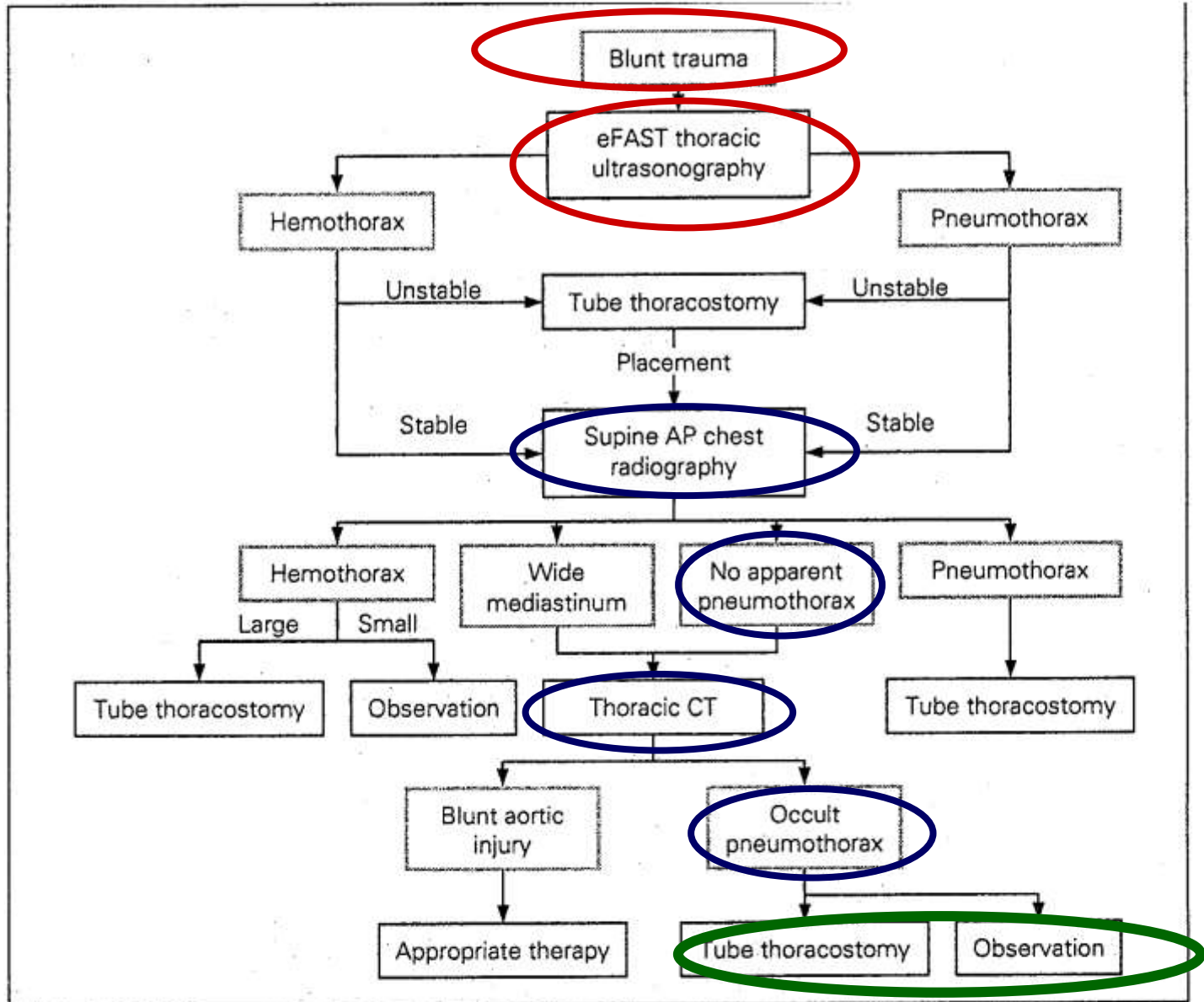
# **Absolute indications for chest tube insertion in case of a PN**

- **Expanding pneumothorax**
- **Respiratory compromise**
- **Tension pneumothorax**
- **Expanding subcutaneous emphysema**

**So, what  
is the  
stuff to  
take  
home ?**



- **An occult PN can occur anytime, in almost any chest trauma patient**
- **An occult PN is small, but the danger is big**
- **Be prepared for the worst and try to convince that tube insertion is more benefit than cost**



**Fig. 1:** Diagnostic algorithm for blunt thoracic trauma. AP = anteroposterior; CT = computed tomography; eFAST = extended focused assessment with sonography for trauma.



**And the last conclusion (this  
time is mine!!!!)**



**Things  
are not  
always at  
they  
seem to  
be**