Acute phlegmonous esophagitis with alcoholic liver cirrhosis

가톨릭대학교 의정부성모병원 최시영

증례정리

31/M Pt. Swallowing difficulty, fever & chest pain을 주소로 방문

과거력 상 alcoholic L/C

내원 당시 child-pugh score; B

2014-03-24

chest CT 시행; acute phlegmonous esophagitis 진단

Lt. pleural effusion 있고 esophageal perforation 의심됨

2014-03-25

GFS 시행 ; Esophageal perforation Dx.

Esophageal stent insertion

VATS & pleural decortication. Lt

2014-03-26

Bilateral pleural effusion 증가하여 chest CT F/U

2014-03-27

VATS & bilateral pleural decortication

2014-04-02

Esophagogram 시행 : stent distal end에 leakage 있어 esophageal stent 추가로 insertion

2014-04-09

F/U esophagogram : no leakage

2014-04-14

Feeding jejunostomy

2015-05-02

Discharge

2014-06-01

Re-admission & chest CT F/U

2014-06-02

F/U GFS

2014-06-03

F/U Esophagogram & start diet

2014-06-11 : Jejunostomy 제거

2014-07-11 : Hematemesis로 ER 방문. -> 대증적인 치료 후 호전

2015-04-17 : 과음 후 chest & back pain 발생 ER 방문 -> GFS & chest CT 시행 : N-S

현재는 PPI 유지하면서 외래에서 경과 관찰 중

Discussion

1. Esophageal stent를 제거하고 수술적으로 재건하는 것이 환자에게 도움이 될 것인지?

Phlegmonous esophagitis

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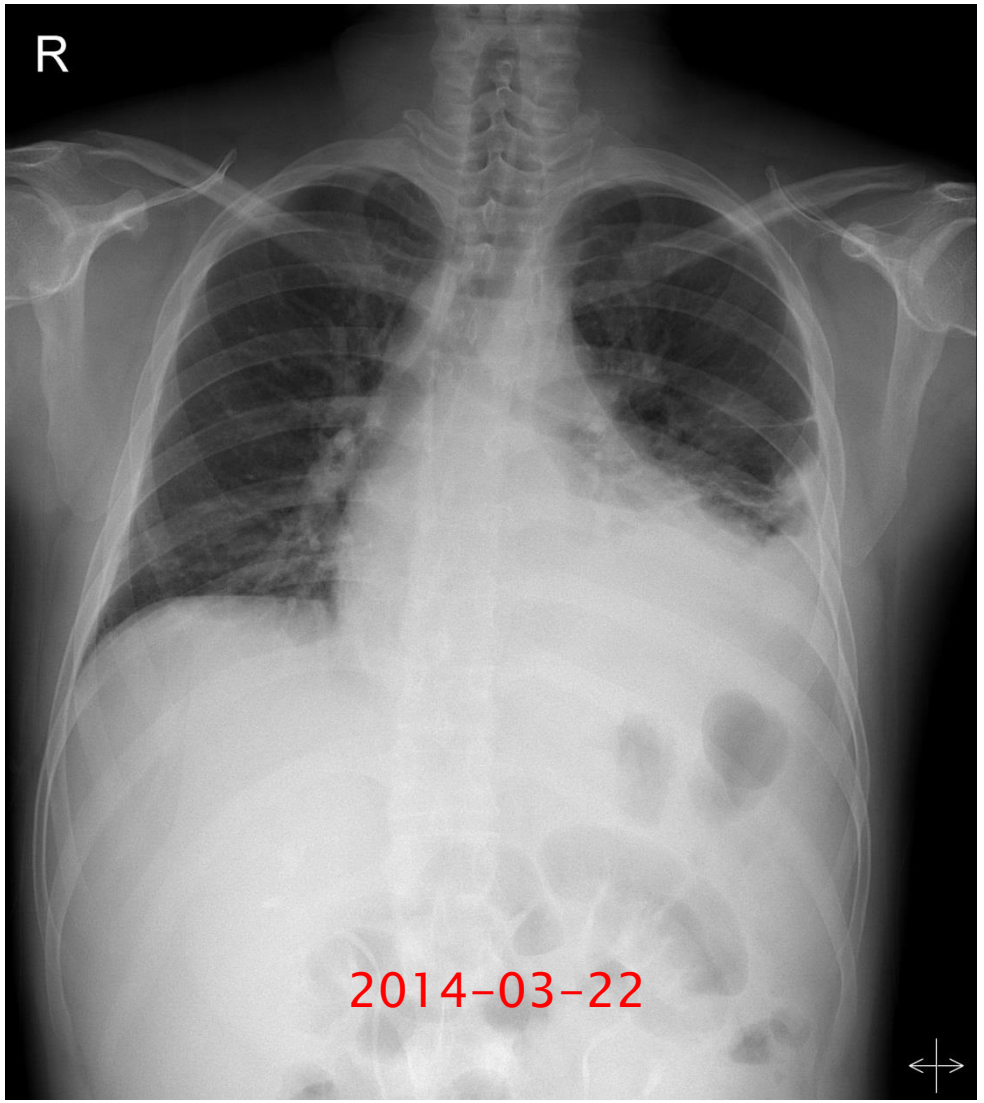
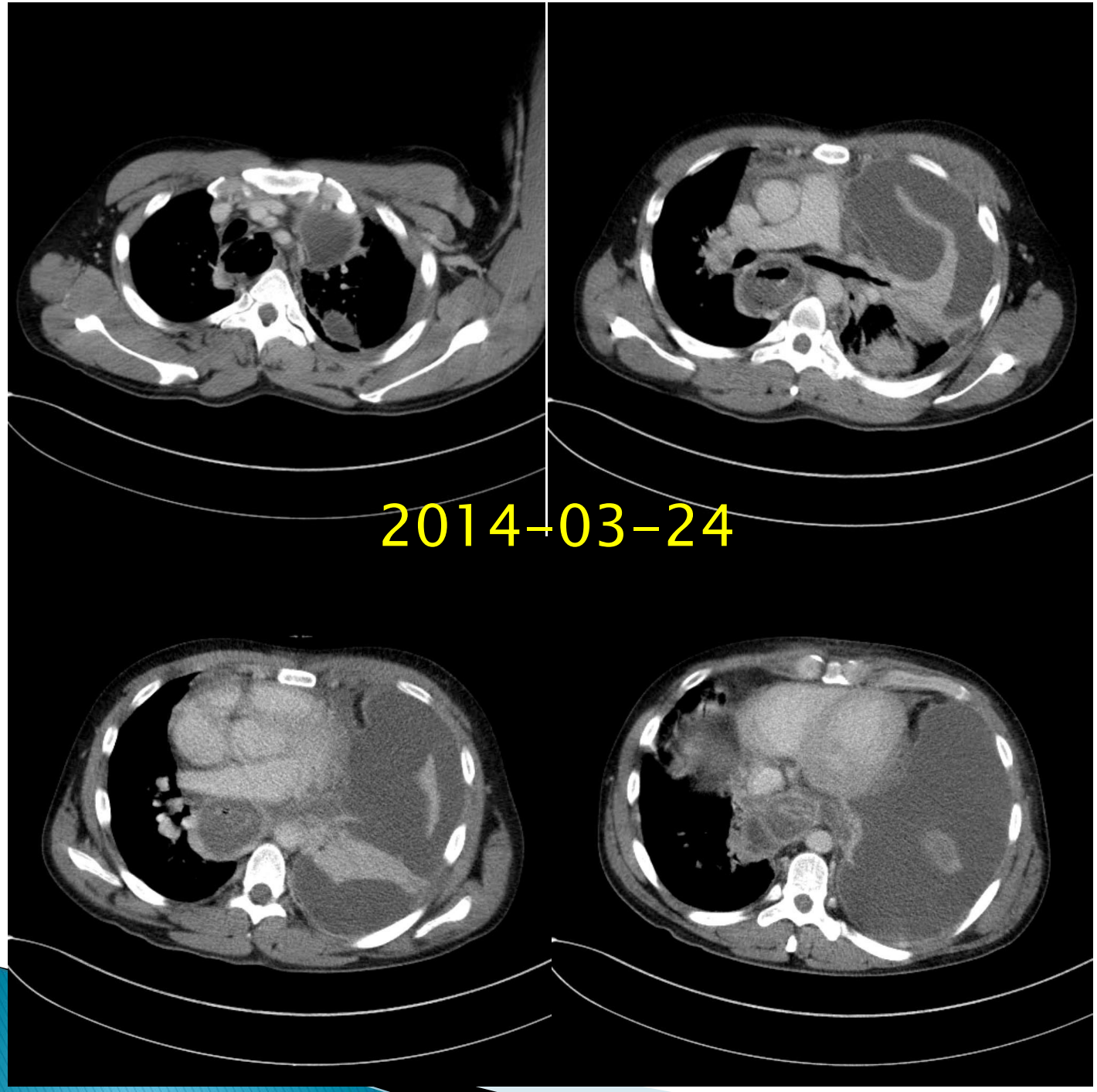
31/M
General weakness & chest pain
P/Hx
Alcoholic L/C

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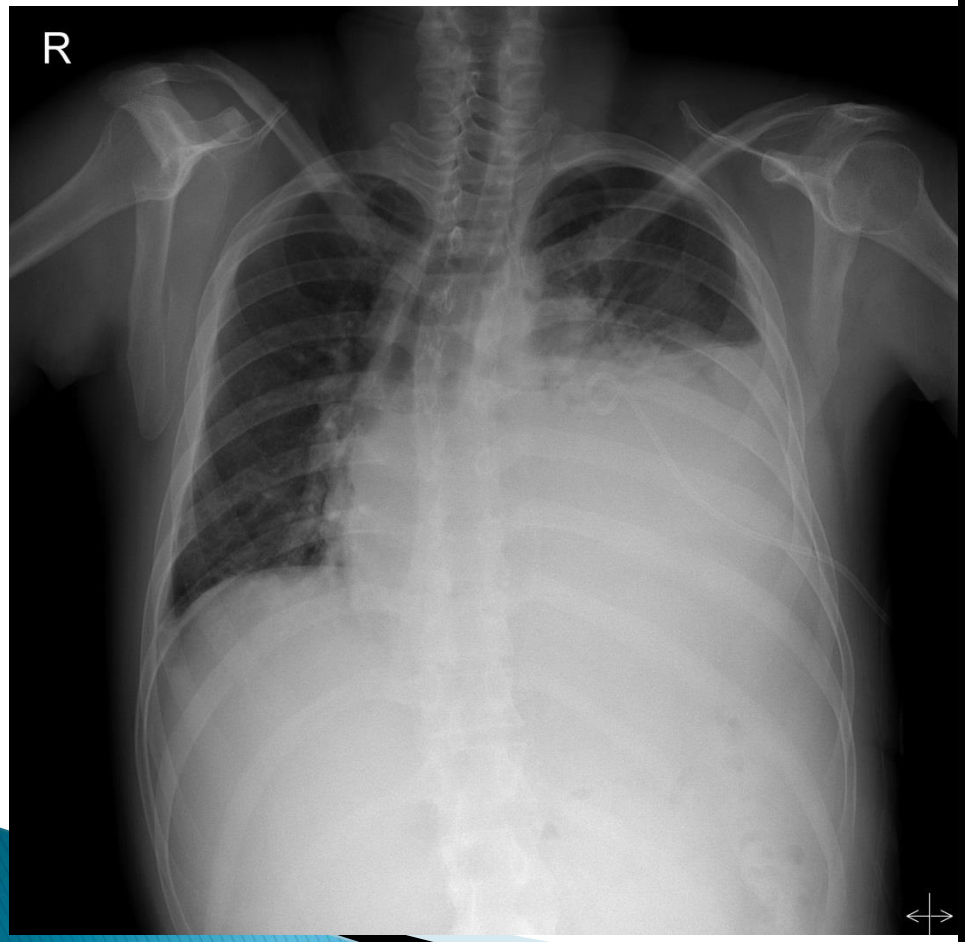
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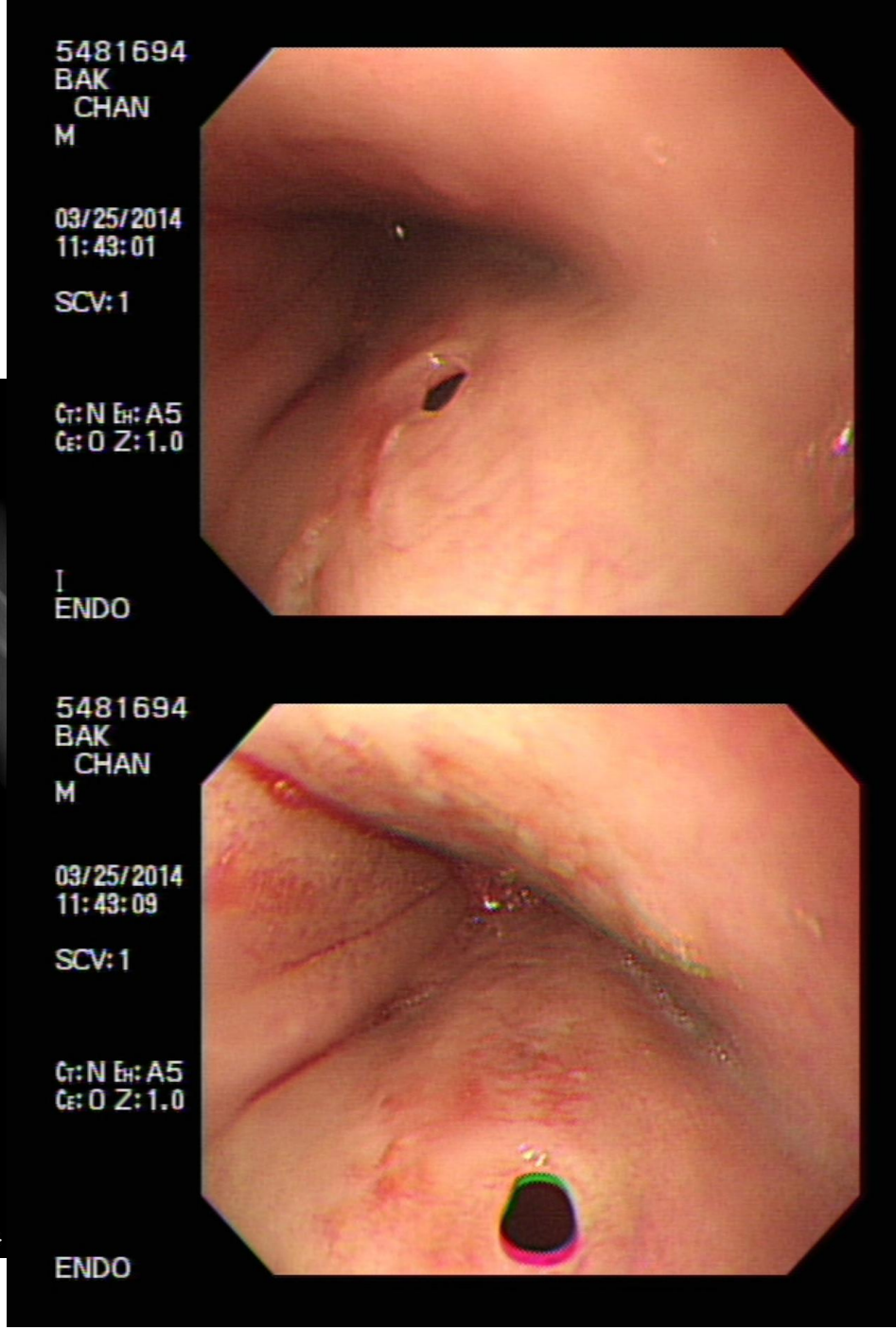
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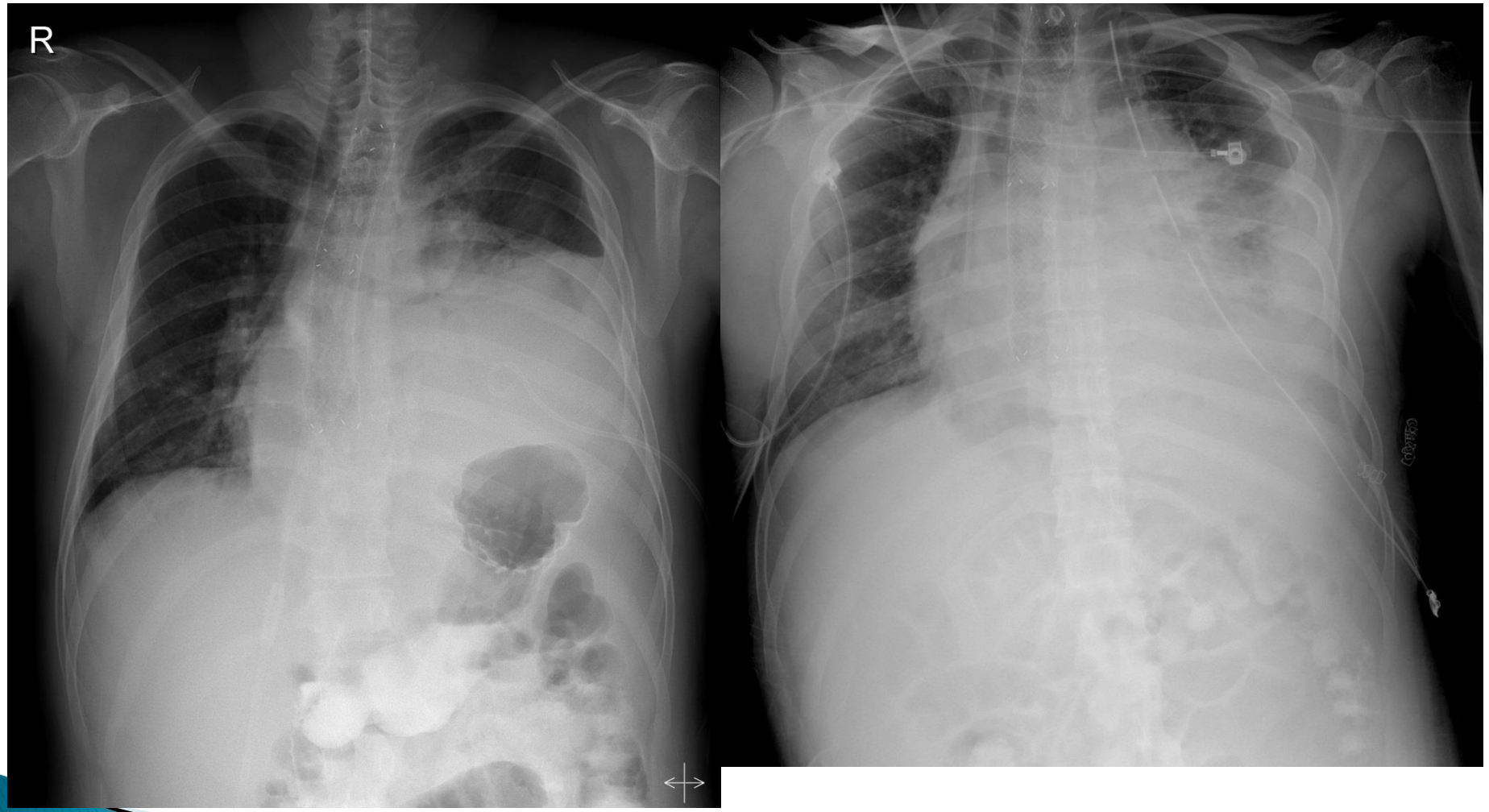
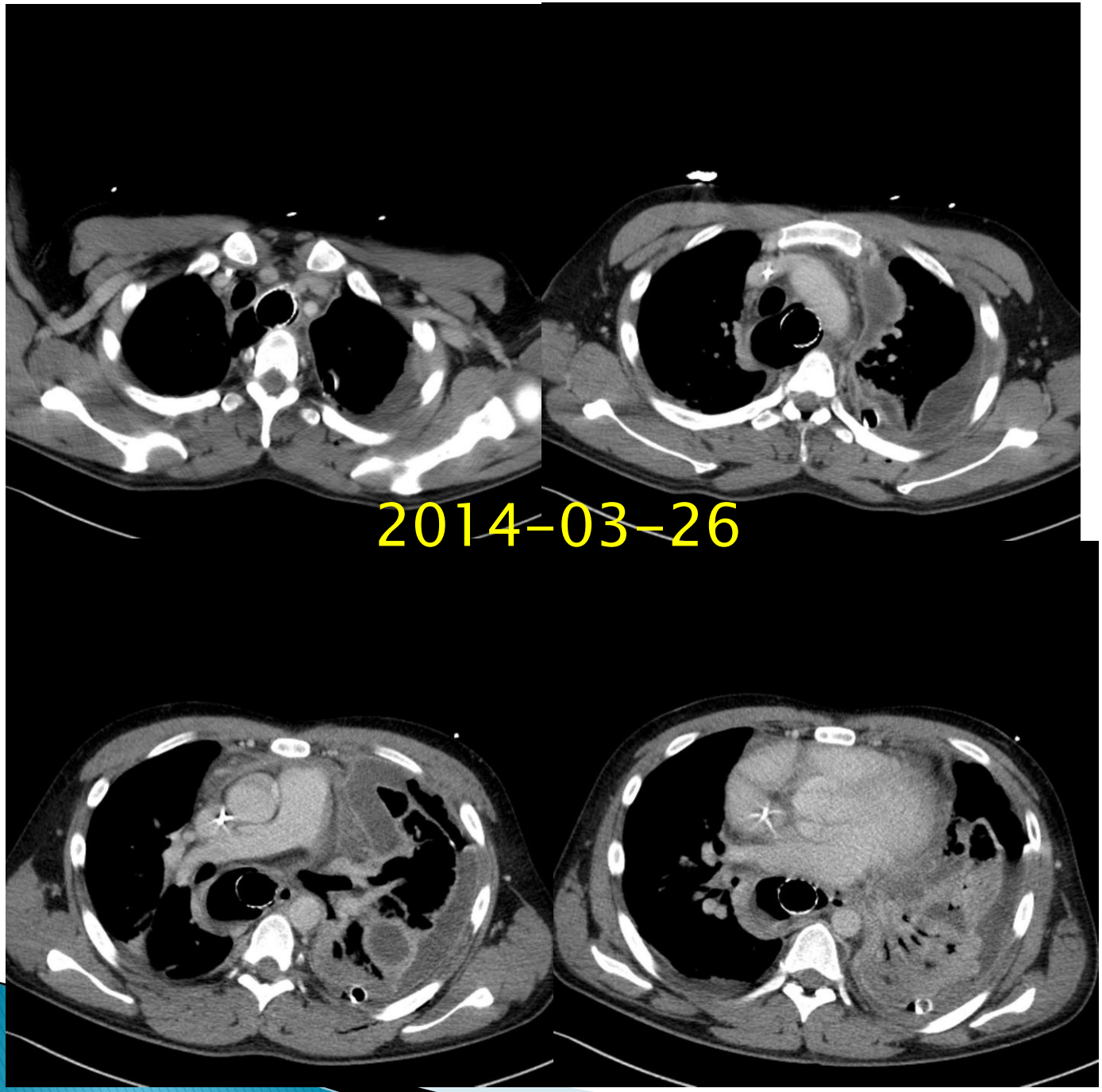
2014-03-25

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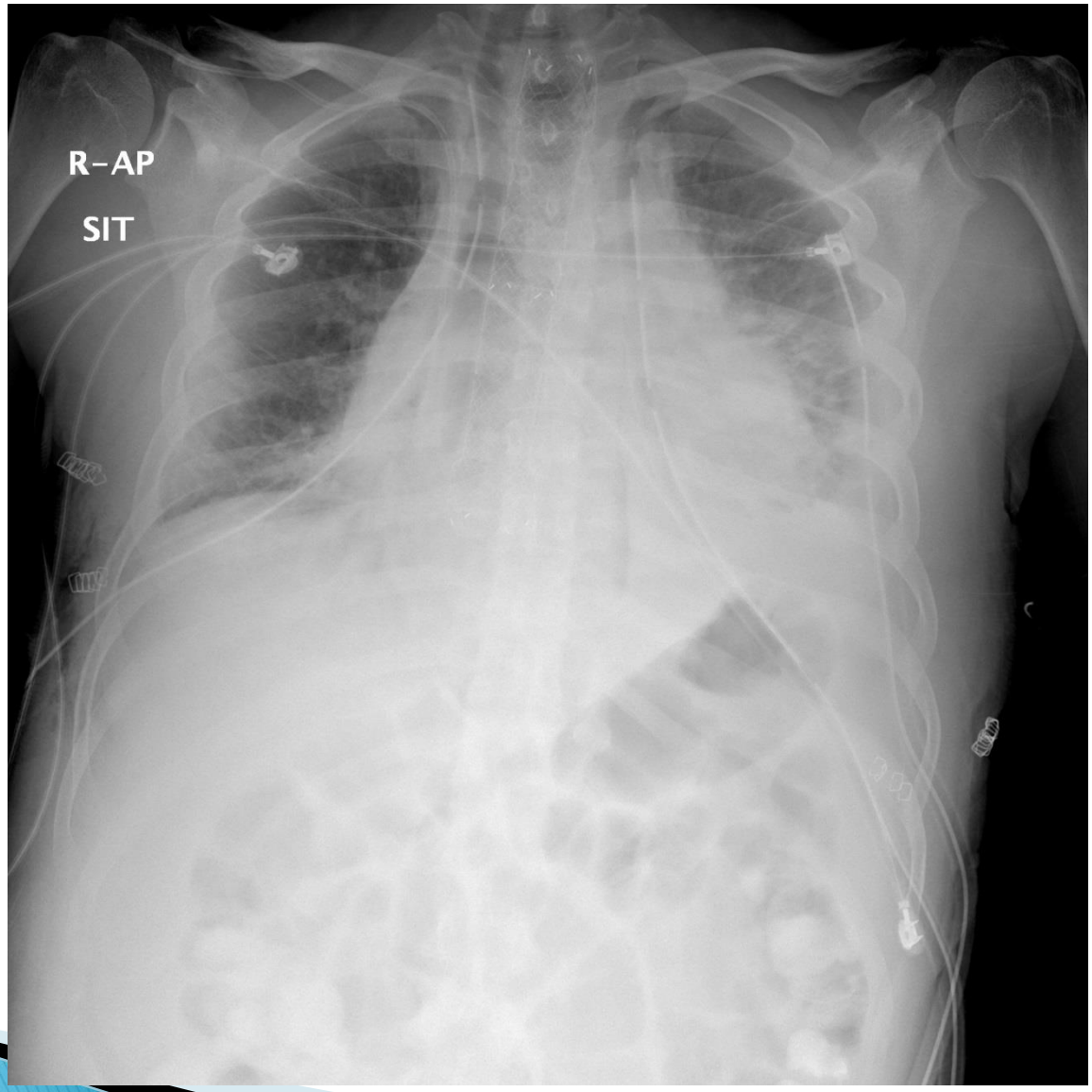

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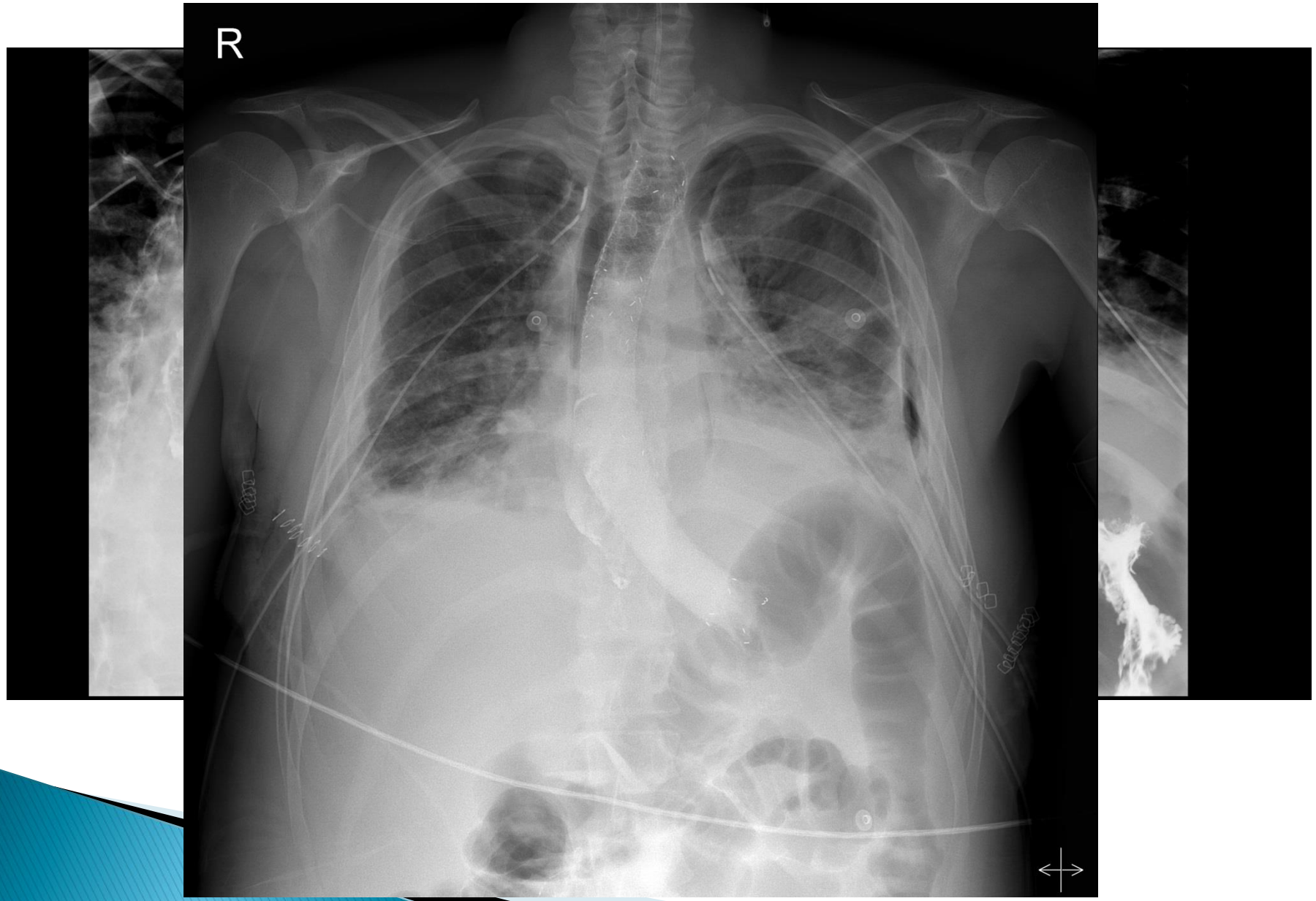

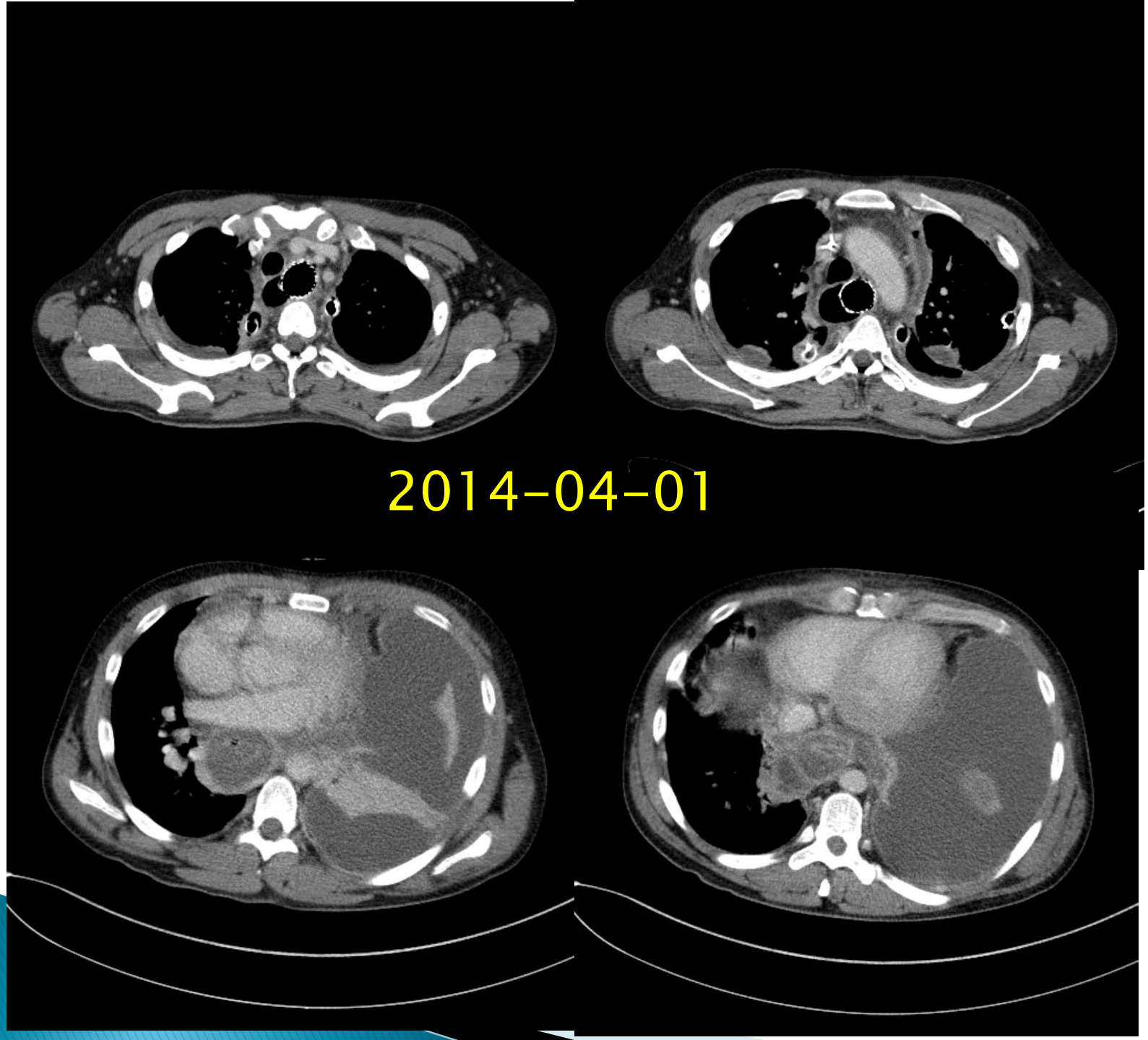
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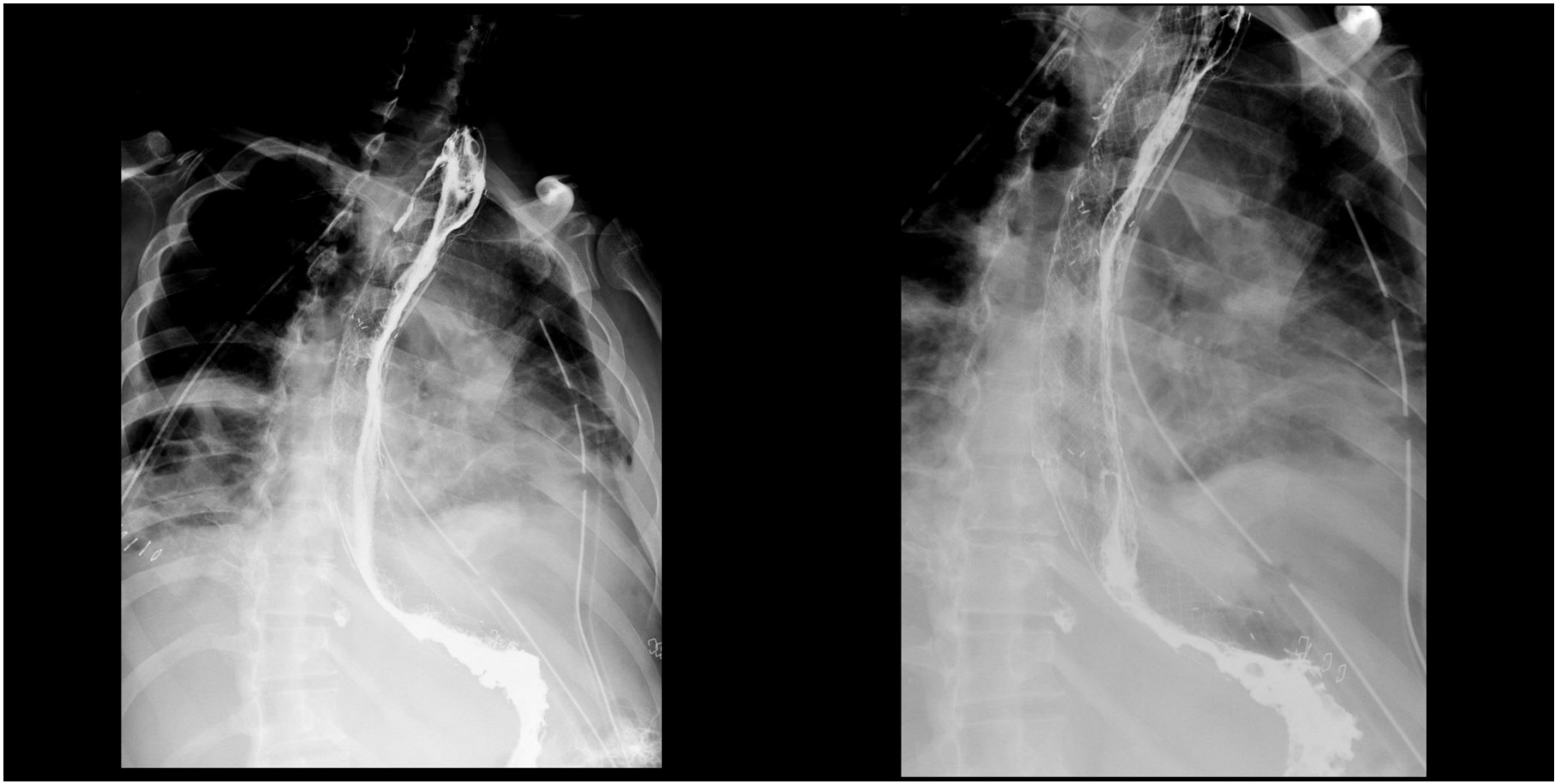

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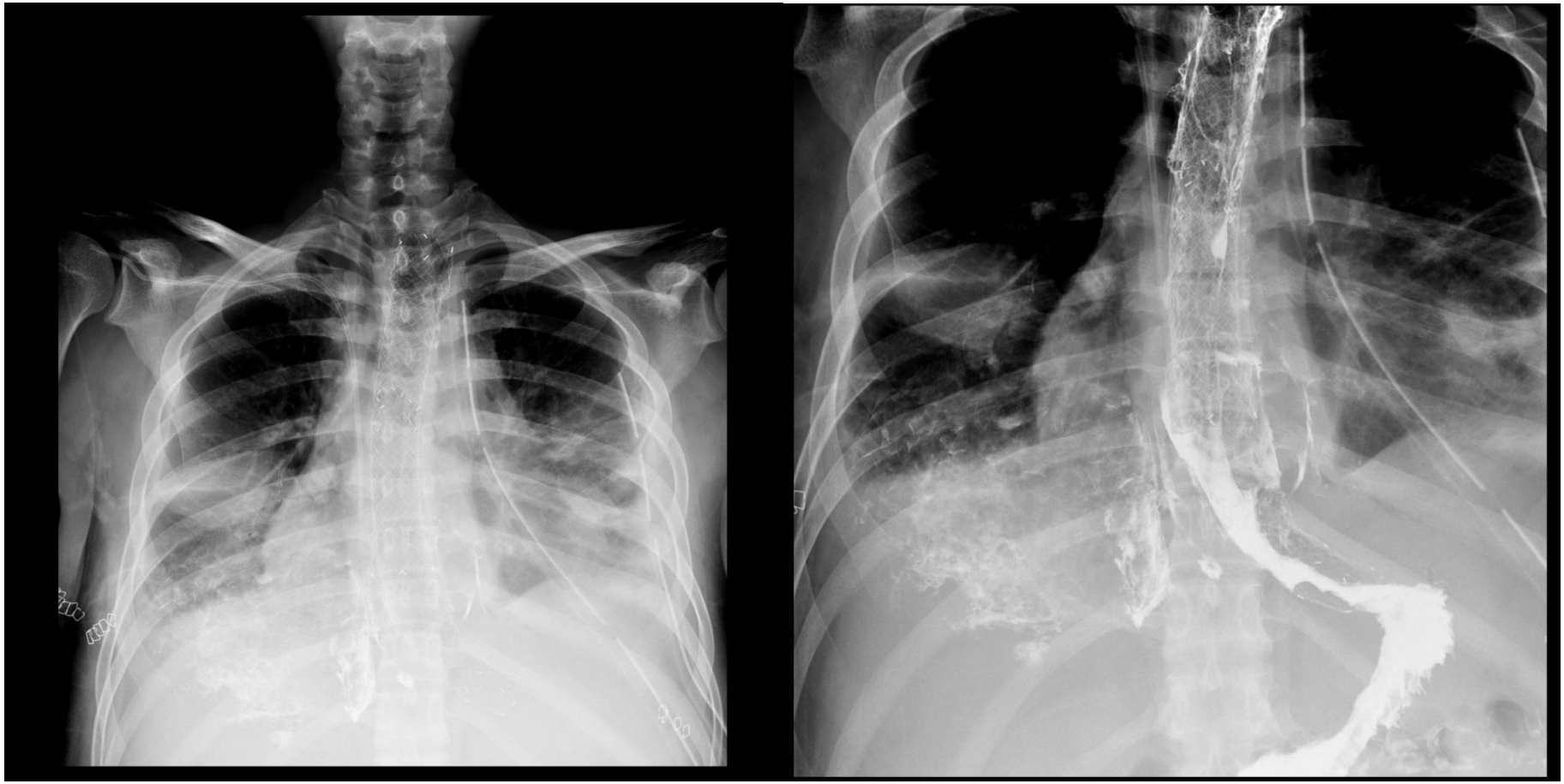

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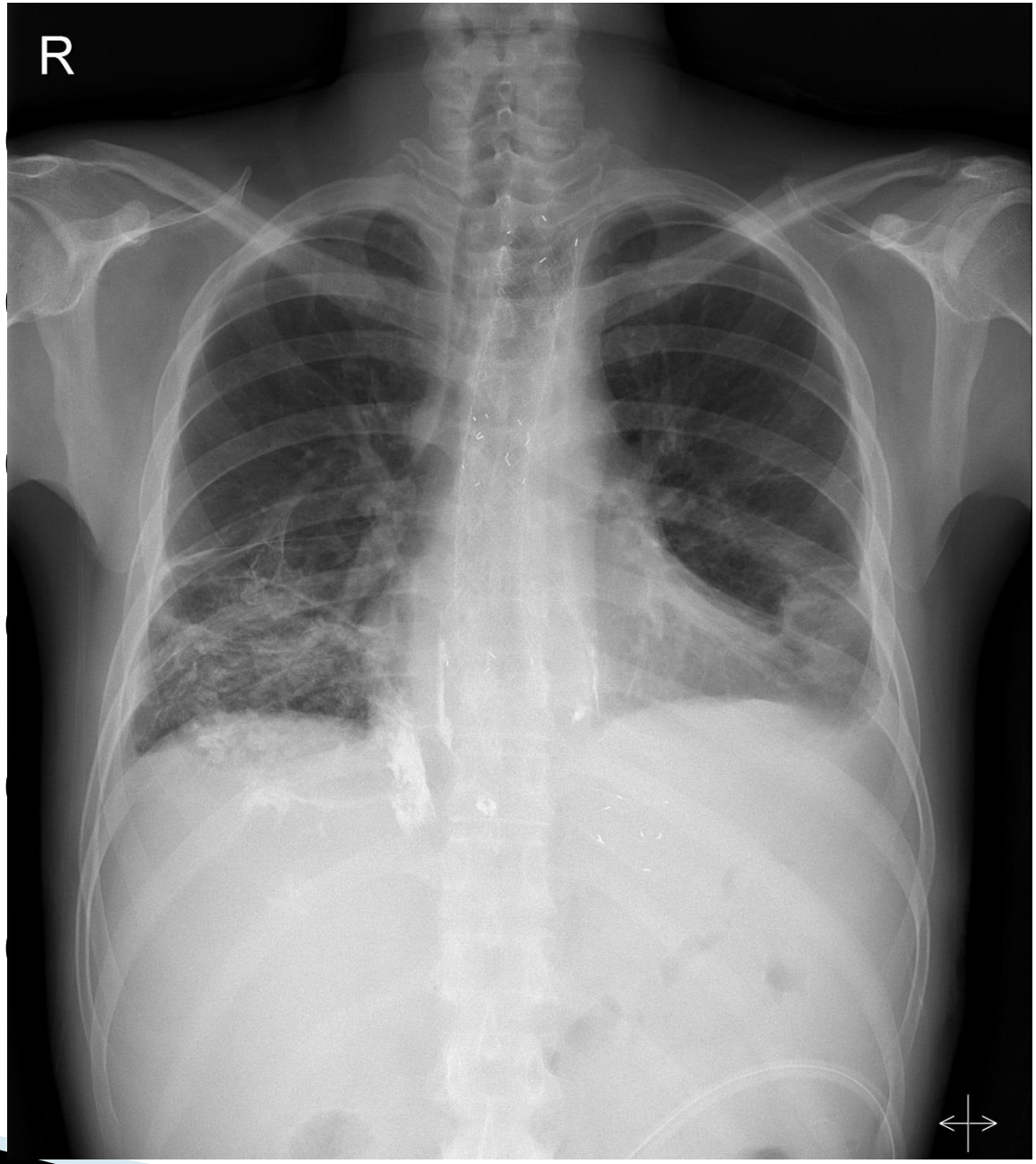


2014-06-01

Re-admission & chest CT F/U

2014-06-02

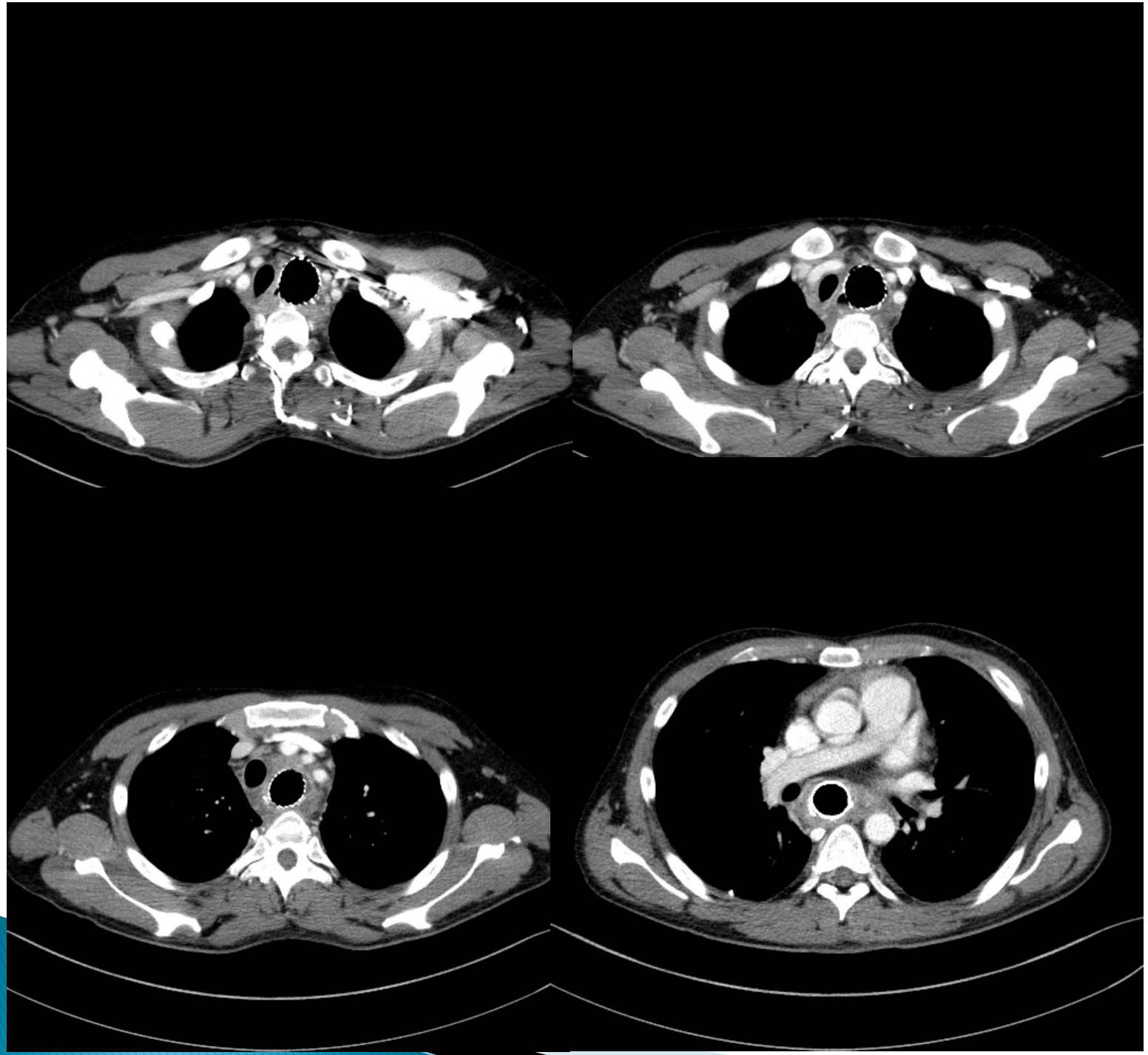
F/U GFS

2014-06-03

F/U Esophagogram & diet

2014-06-11

Jejunostomy takedown



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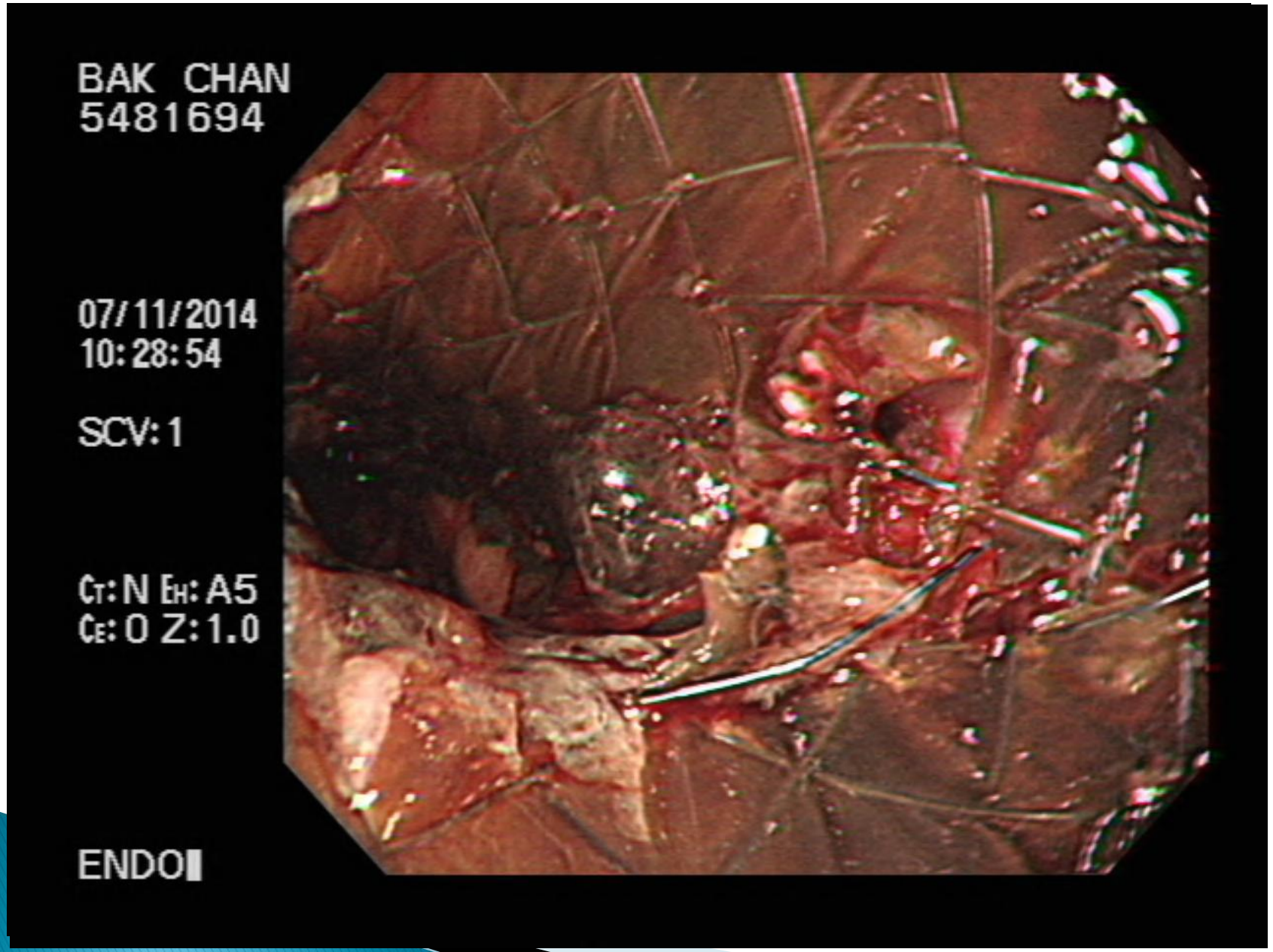

Extrapleural Pneumonectomy for Malignant Pleural Mesothelioma

가톨릭대학교 서울성모병원 흉부외과

김경수, 박재길

54/M

C/C

Incidentally found pleural effusion

P/I

4 개월 전 상지 수술 시 촬영한 CXR 에서 우연히 흉수가 발견됨.

Exudate (ADA 77.9)로 R/O Tbc pleurisy 진단 하에 2 개월간 항결핵제 투약하였으나 effusion 지속됨.

VATS pleural & RUL biopsy 후 malignant mesothelioma, epithelioid type 으로 진단되어 전원 되어 옴.

P/H

DM/HBP/Tbc/Hepatitis (-/-/-/-)

alcohol/smoking : social/ex-smoker

Occupation : 건축업 (천장마감재) 20 년

ECOG : 0

Op. title

Extrapleural pneumonectomy, Rt.

with diaphragm & pericardium reconstruction with Gore-tex patch. (R0)

Pathologic Results

Tumor site : right parietal and visceral pleura, diffuse : maximum thickness : 0.5cm

Pleural plaque : up to 7.7 cm, multiple

pericardium, diaphragm : involved

Rt. lung parenchyme & Endothoracic fascia : not involved

Lymphatic invasion (-), margin involvement (-)

LN : #4 (0/4), #7 (0/2), #10~#13 (0/25)

Staining & Immunochemistry

[SPECIAL STAINING]

Elastic : focal invasion to the pleural elastic layer

Prussian blue : not identified for asbestos bodies

[IMMUMOHISTOCHEMISTRY]

Calretinin (+), EMA (+), P53 (-) : <10%, Wilms Tumor 1: focally (+), Podoplanin : focally (+)

Dx : Malignant pleural mesothelioma, epithelioid type, pT3N0M0

Clinical Course

Uneventful & D/C (POD #9)

FU without adjuvant Tx.

Discussion Points

1. Indication for extrapleural pneumonectomy or pleurectomy/decortication

2. Proper choice for adjuvant Tx.: Chemotherapy±Radiotherapy±Immunotherapy

Two Cases of Thymoma with Paraneoplastic Syndrome

서울대학교병원 흉부외과

황유화, 강창현, 김응래, 박샘이나, 이현주, 박인규, 김영태

Thymic malignacy is often associated with paraneoplastic syndromes (PND) and recognition of these disorders is important for physicians who treat these patients. The most common thymoma-assoaicated PNDs are myasthenia gravis (MG), Lambert-Eaton myasthenic syndrome, pemphigus, subacute sensory neuronopathy, pure red cell aplasia, and immunodeficiency. Most of these are autoimmune or endocrine-related. Here, we report two cases of thymoma with paraneoplastic syndrome, which develope minimal change disease after thymectomy due to thymoma and Good's syndrome mimicking pulmonary tuberculosis.

A 44-year-old man presented with continuous couhing and mediastinal mass with pleural seeding. First, he underwent neoadjuvant chemotherapy c CAP. The mass invaded the lung, pherenic neve. We did the total thymectomy and en-bloc resection of pericardium via sternotomy and left upper lobectomy via thoracotomy and partial parietal pleurectomy and thoracic duct ligation via right thorascopy. He was confirmed 15cm sized thymoma B3. 17days after removal of the thymoma, nephrotic syndrome appeared. Renal biopsy revealed diffuse foot process effacement, suggesting minimal change disease. There was no evidence of other autoimmune disease or causes of the nephropathy. Treatment with steroid for three days followed by hemodialysis for 2 weeks was started. After 6 week later, his nephrotic syndrome was almost improved with cyclosporine A.

A 22-year-old man presented with cough and chest discomfort with mediastinal mass with multiple lung nodules and systemic enlarged lymph nodes. First, he underwent thoracoscopic lung biopsy under suggesting pulmonary tuberculosis. He confirmed necrotizing bronchiolitis. The thymic tumor was surgically removed. He was diagnosed as 9cm sized thymoma B1 with Good's syndrome. 15days after surgery, pericardial effusion and pleural effusion were developed. Treatment with 500 mg methylprednisolone IV for three days followed by oral 60 mg prednisolone daily was started. After 4 weeks, Good's syndrome was improved

Staged Management of Tracheo-gastric fistula after esophagectomy

서울아산병원 복진산, 이강훈, 황수경, 최세훈, 김형렬, 김용희, 김동관, 박승일

63세 남자 환자가 1개월 전부터 시작된 연하곤란을 주소로 내원하였다. 35년 전 충수염 천공으로 수술 받은 과거력이 있었고, 검사 후 UI 20 ~26cm에 위치한 식도암 (squamous, cT1bN0M0)으로 진단되었다. 환자는 수술적 치료를 위해 Mckeown 수술을 시행받았다. 흉강과 복강 내에 유착이 있었으며, 특히 심한 복강 내 유착으로 위장관 도관을 길게 사용할 수 없어 경부 식도-위 문합을 manual suture로 시행하였다. 수술 후 문합부위 누출은 없었으나 기침, 가래가 증가하여 시행한 기관지 내시경과 흉부 CT에서 기관-위장관 누공이 의심되어 수술 후 21일에 누공 제거 수술을 시행하였다. 기관과 위장관 도관의 유착이 심하여, 위장관 도관을 절개한 후 누공을 일차 봉합하고 serratus anterior muscle flap으로 보강하였다. 위장관 도관 절개 부위 주변의 허혈과 괴사가 심하여 절개 부위를 봉합할 수 없었고, 유착이 심하여 위장관 도관을 제거하기도 어려워 도관 내에서 절개 부위 근위부와 원위부를 봉합하였다. 식도는 목에서 식도루를 만들어 배액하였다.

수술 후 기관지 내시경에서 기관-위장관 누공은 호전되었으나 흉강 내 감염이 호전되지 않아 첫 수술 후 57일에 위장관 도관 제거 수술을 시행하였다. 복부로 접근하여 복강 내 위장관 도관을 제거하고 남아 있는 흉강 내 도관에는 배액관을 거치하였으며 공장루를 만들었다. 수술 후 패혈증과 급성 신부전이 발생하였으나 호전되어 수술 후 62일에 퇴원하였다.

첫 수술 후 7개월에 대장 간치술 (colon interposition)을 시행하였다. Left colic artery를 사용하여 30cm 길이의 대장 도관을 준비하였으나 근위부의 허혈이 관찰되어 부분 절제하고 20cm 길이의 공장 도관을 추가로 준비하였다. 흉골 절개 후 공장 도관의 혈관을 left internal thoracic vessel에 연결하고 식도-공장-대장-공장 순으로 문합하였다.

수술 후 문합 부위 누출 소견은 없었으나 수술 창상 열개 (wound dehiscence)로 수술 후 22일에 복직근 근피판 수술 (TRAM flap)을 시행하였다. 이후 창상 부위 호전되어 수술 후 98일에 합병증 없이 퇴원하였다. 첫 수술 후 3년 경과한 현재, 재발 소견 없이 정상적인 경구 식이를 하고 있다.

Management of lung cancer with poor lung function

서울아산병원 호흡기내과 송진우

서론

수술은 여러가지 요인(마취제, 통증 자체 및 진통제 사용에 의한 기침과 호흡의 억제, 비기동화, 장기간의 앙와위 등)에 의해 폐기능에 큰 변화를 초래하며 이에 따라 수술 후에는 여러가지 호흡기계 합병증이 잘 발생한다. 수술 후 호흡기계 주요 합병증은 무기폐, 기관지염, 폐렴, 호흡부전, 폐색전증, 기관지 경련 및 사망 등으로 이러한 합병증의 발생은 입원기간을 연장시키거나 환자의 이환(morbidity)과 사망률을 증가시킨다. 수술 전 폐기능 평가는 특정 환자에서 수술 후 호흡기계 합병증 발생 위험을 평가하고 수술 전후에 적절한 조치를 가동함으로써 합병증 발생을 예방하거나 최소화하는데 그 목적이 있다.

1. 수술에 따른 폐기능의 변화

가. 폐용적의 변화

수술 후 폐용적의 변화는 폐활량(vital capacity) 감소가 가장 선행하며, 수술 후 2-4일 후 최대로 감소하고 약 1-2주 정도 지나야 회복된다. 폐활량은 수술 전에 비해 약 50-60 % 정도 감소하며 기능적 잔기량(FRC)은 약 30 % 정도 감소한다. 폐용적이 감소하는 기전은 주로 횡경막의 자극에 대한 반사적 억제(reflex inhibition of diaphragmatic stimulation) 때문이며 통증도 일부 기여한다. 수술 후 호흡기합병증의 발생에는 FRC와 폐쇄용적(closing volume)의 상대적 변동이 중요한 요인으로 그 관계에 따라 무기폐나 저 환기-관류비 병소 (low ventilation-perfusion) 여부가 결정된다.

나. 호흡양상의 변화

수술 후는 마취제나 진통제, 특히 마약성 진통제(narcotic analgesics) 등의 사용으로 호흡 중추가 억제되며, 한숨(sighing)의 감소로 인해 무기폐가 잘 생기고 폐탄성 역시 감소되며 FRC도 감소한다.

다. 가스교환의 변화

수술 혹은 마취 후 초기 수 시간 내에 발생하는 것은 주로 마취제 등의 효과에 의한 것이며 보통 24시간 내에 회복된다. 흉곽, 또는 상복부 수술 후 수일 혹은 수주 간 가스 교환 장애가 지속될 수 있는데 이는 폐쇄용적(closing volume, CV) 증가, 기침억제 및 기도 섬모운동 장애 등과 관련이 있다.

2. 수술 후 호흡기 합병증의 위험인자와 대응

가. 수술 전 위험인자(Preoperative risk factors : patient-related risk factors)

(1) 흡연

흡연은 만성폐질환 유무에 관계없이 수술 전후 사망 위험도를 1.4-4.3 배 증가시킨다. 특히 흡연

력이 20갑년 이상 되면 그 위험도는 더 증가한다. 흡연이 심맥계 및 호흡기계에 미치는 생리학적 영향은 첫째, carboxyhemoglobin 증가(3-15%) 및 조직에서의 산소해리 억제로 동맥혈 산소함유량 및 조직 산소전달량을 감소시킨다. 충분한 carboxyhemoglobin clearance를 위해서는 12 내지 18 시간 금연이 필요하다. 둘째, 담배 내 nicotine은 농도의존적으로 전신혈관수축 및 심박수 증가를 일으켜 혈압을 상승시킨다. 이러한 흡연 효과는 20분 금연 후 소실된다.

권장: 흡연에 따른 심혈관계 부작용을 해소하기 위해서는 적어도 수술 전 12-24 시간 동안 금연할 것이며 수술 후 호흡기계 합병증 빈도를 줄이기 위해서는 수술 전 8주 동안 금연할 것이 권장된다.

(2) 나이

호흡기 합병증은 연령적 나이보다는 환자의 전반적 건강상태나 동반질환 여부에 의해 더 많이 결정된다. 따라서 고령이라는 것만으로 필요한 수술을 금해서는 안된다.

권장: 아직까지 연령자체가 호흡기 합병증에 대한 독립적 위험인자인지에 대해선 명확한 답이 없는 상태이나 FEV 1 이 2 L 미만인 60세 이상의 환자는 개흉술 후 사망률이나 중대 합병증 발생 가능성이 더 높을 것으로 예상하는 것이 일반적이다.

(3) 비만

지방이 흉벽과 횡경막 등에 침착되면 폐탄성을 최대 60 % 까지 감소시키고 호흡의 일(work of breathing)을 증가시킨다. 그러나 비만 자체는 술 후 합병증의 중대한 위험인자는 아닌 것으로 여겨진다.

권장: 수술을 앞둔 비만 환자에서는 폐기능검사와 동맥혈가스분석검사를 시행하여 정상 여부를 확인할 것이 권장한다. 수면무호흡증(Sleep apnea syndrome)이 있는 비만 환자의 경우는 수면다원검사와 갑상선 기능 검사를 시행하고 응급상황이 아니면 수술을 연기하고 체중을 감량한 뒤에 수술을 하도록 권고한다.

(4) 상기도 감염

바이러스성 상기도감염 후 몇 주가 지난 후에도 기도 반응성(airway reactivity)과 기도저항 증가 상태가 지속될 수 있으며 또한 횡경막 부전(diaphragmatic dysfunction)도 동반될 수 있다

권장: 현재까지는 상기도 감염이 있는 경우에 대해서 확실한 자료가 부족한 형편이나 선택 수술(elective surgery)은 가능한 한 연기하도록 권고한다.

(5) 만성폐쇄성폐질환

수술 후 호흡기합병증 발생의 가장 중요한 위험인자의 하나이다. COPD가 있는 환자는 없는 환자와 비교하여 수술후 폐합병증 비교위험도가 2.7 - 4.7 배 로 알려져 있다.

권장: 급성악화가 있는 COPD이면 수술을 연기해야 하고, 수술전 관리는 일반적인 COPD 급성악화에 준한다. 즉 금연을 권하고, 흡입 기관지확장제(ipratropium, beta-adrenergic agonist)를 쓰고, 이들만으로 조절되지 않으면 theophylline을 추가사용한다. 감염의 증거가 있으면 항생제를 사용해야 하나 예방적 항생제 요법은 효과가 없는 것으로 알려져 있다. 기관지확장제 치료로 증상의 호전이 없거나 폐기능검사상 호전이 없으면 약 2 주 정도 전신적 스테로이드 치료를 고려할 수 있다.

(6) 기관지천식

과거 보고에 의하면 천식환자에서 수술 후 호흡기합병증의 빈도는 약 24% 정도였으나 최근 보고에 의하면 수술 전 기관지확장제나 스테로이드 등으로 조절된 천식 환자의 경우 수술 후 기관지

경련 합병증은 약 1.7 % 정도로 낮다. 기관지 경련 합병증은 특히 수술 첫 수 시간 내에 잘 생긴다.
권장: 수술을 받기 위해서는 천명음(wheezing)이 들리지 않아야 하고 폐기능이 정상예측치의 80 % 이상으로 유지되어야 한다. 최근 6 개월 내에 전신적인 스테로이드를 사용한 경력이 있는 환자는 수술 전 최소 6 시간 전에 전신적 스테로이드를 투여한다. 이러한 용도로 수술 전 사용하는 전신적 스테로이드는 수술 후 감염이나 상처 치유에 영향을 미치지 않는 것으로 알려져 있다.

나. 수술 중 위험인자 (Intraoperative risk factors)
(1) 마취의 종류
척수마취(spinal anesthesia)나 경막하마취(epidural anesthesia)가 전신마취보다 수술 후 호흡기계 합병증 빈도가 최소한 비슷하거나 또는 적다. 또, 국소마취(regional anesthesia)는 첫수마취, 경막하마취 및 전신마취보다 호흡기계 위험도가 적다.
권장: 수술 후 호흡기계 합병증이 생길 가능성이 높은 고위험 환자에게는 가능하면 국소마취, 척수마취, 또는 경막하마취를 권장한다.
(2) 수술 부위
수술 후 호흡기계 합병증의 가장 중요한 위험인자이다. 상복부 수술이나 흉부 수술이 위험도가 가장 높으며 합병증 발생 빈도가 10-40 %에 이른다. 상복부 수술 후에는 횡경막의 작용이 감소하고 흉곽의 근육이나 복부 호기 근육의 사용이 증가하는데, 이는 주로 횡경막에 대한 반사적 억제 때문이다. 간이식은 복부 수술 중에서도 마취시간이 길고 패혈증이나 폐렴과 연관된 급성호흡곤란증후군 등 호흡기합병증이 발생할 확률이 매우 높다. 또한 간질환으로 인한 폐내단락으로 수술 전에 저산소혈증을 보이는 경우도 많다.
(3) 피부 절개선 유형
수직 개복절개(vertical laparotomy incision)이 평행개복절개(horizontal laparotymy incision)보다 폐활량 감소가 더 크고 수술 후 호흡기계 합병증의 위험이 더 크다.
(4) 수술 중 근이완제 사용
약리작용 시간이 긴 pancuronium을 사용하면 수술 후 저환기(hypoventilation)를 조장하여 호흡기계 합병증 발생 위험이 증가한다.

다. 수술 후 위험인자 (Postoperative risk factors)
(1) 부적절한 통증관리
수술 후 통증은 기침과 심호흡을 억제하고 조기 기동(ambulation)을 방해하여 호흡기계 합병증의 빈도를 증가시킨다. 따라서 수술 후 초기 적절한 통증 관리는 환자 관리에 매우 중요하다. 그리고 경막하 진통법(epidural analgesia)으로 수술 후 통증을 관리하는 경우 호흡기계 합병증이 감소되는 것으로 알려져 있다. 경막하 진통법은 비교적 안전하고 호흡억제 유발 빈도는 많지 않으며, 혈압저하가 생기더라도 치료에 잘 반응하여 환자의 이환(morbidity)을 증가시키지 않는다.
(2) 비기동화(immobilization): 수술 후 장기간의 비기동 상태는 호흡기계 합병증을 증가시키는 요인이다.

3. 폐절제술 환자에서의 폐기능 평가법

폐절제술을 예정한 환자는 절제 범위와 관계없이 원칙적으로 폐기능을 평가해야 하고 수술 중 외과의가 전폐절제술(pneumonectomy)까지 하게 될 수 있다는 상황을 염두에 두고 검사를 시행하여야 한다.

가. 1단계 검사: routine pulmonary function tests

(1) 폐활량측정(spiirometry)

(2) 확산능(diffusing capacity)

(3) 동맥혈가스분석검사(ABGA)

전통적으로 수술 전 과탄산혈증은 폐절제술의 부적응증으로 여겨져 왔으나 아직 확립되지 않은 기준이다.

나. 2단계 검사: tests of unilateral lung function

1단계 검사에서 적합한 기준 이상이면 시행하지 않는다. 2단계 검사는 특히 전폐절제술을 예상하는 경우 절제 예상 폐와 수술 후 남는 폐의 기능을 개별적으로 평가하는데 유용하다.

(1) 정량적 폐주사(quantitative lung scanning)

방사성동위원소를 이용, 폐의 국소적 해부-생리학적 상관성(anatomic-physiologic correlation)을 볼 수 있으며 수술로 제거될 부분과 남을 폐의 기능을 평가하는 방법이다. 일종의 'Radiospiromtery'의 개념이며 관류주사는 99mTc-radioactive aggregates를, 환기주사는 133Xe gas를 각각 이용한다. 전폐절제술의 경우 Postoperative FEV1=Preoperative FEV1 × (% of total function contributed by the lung to remain)으로 계산하며 폐활량검사상 FVC와의 상관계수는 0.73- 0.75, 그리고 FEV 1 과는 0.63-0.72 정도이다. Postpneumonectomy FEV1 이 1.0–0.8 L 미만, 또는 예측 정상치 35 % 미만으로 예측되면 physiologic inoperability로 판단한다. 엽절제술의 경우의 예측식은 Preoperative FEV1 × (number of remaining segments/total number of lung segments [= 19])이다. 이 방법은 쉽게 가용하고 거의 위험이 없으며 비교적 높은 상관계수 때문에 가장 많이 쓰이는 2단계 검사라 할 수 있다.

다. 3단계 검사: exercise testing

운동검사의 이론적 배경은 환자의 심폐계와 산소전달계에 부하를 가함으로써 수술 후 남을 심폐계의 여력(reserve)을 평가하고자 하는 것이다. 주로 cycle ergometer를 이용하며, 호흡곤란정도, 폐혈관저항 증가 정도 및 최대산소섭취량(VO 2 max: <1 L/min, <10-15 ml/kg/min면 사망률이나 수술 후 합병증 발생 증가) 등의 3가지 지표를 평가한다.

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Surgical Management of Lung Cancer with Poor Pulmonary Function

서울대학교병원 박인규

Contents

- Benefit and Risk of Surgery
- Selection of Patient
- Technical perspective
  - Extent of pulmonary resection
  - Technique
- Postoperative care

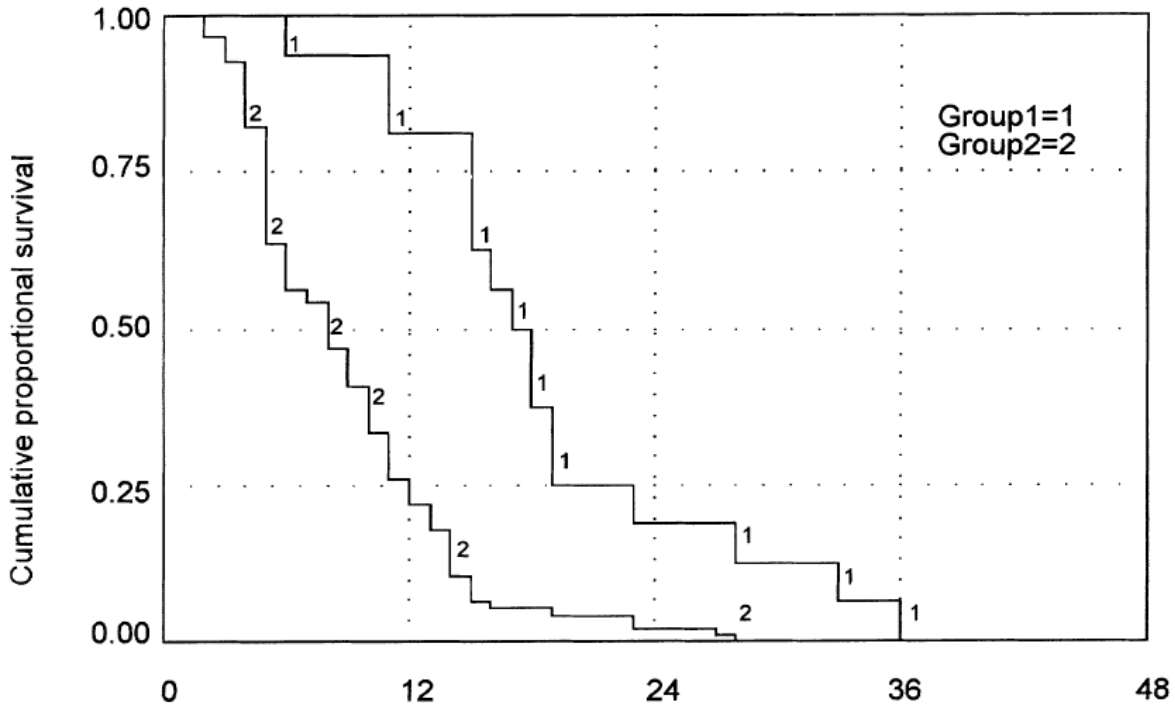
Benefit of surgery

Survival of Untreated NSCLC

Chest 1994;106:1797-1800

Table 1—*Number of Untreated Patients With Non-Small-Cell Lung Carcinoma and Median Survival According to the Different TNM Subsets Included in This Study*

TNM Subset	No. of Patients	Median Survival, mo
T2, N0, M0	19	17
T2, N1, M0	31	11
T2, N2, M0	9	10
T2, N0, M1	7	7.50
T2, N1, M1	18	5.25
T2, N2, M1	22	4.50
T3, N2, M0	8	7.25
T3, N2, M1	16	6.50
Total	130	9.00



LCSG-821

Lobectomy vs limited resection
1983-1988; 247 T1N0 pts

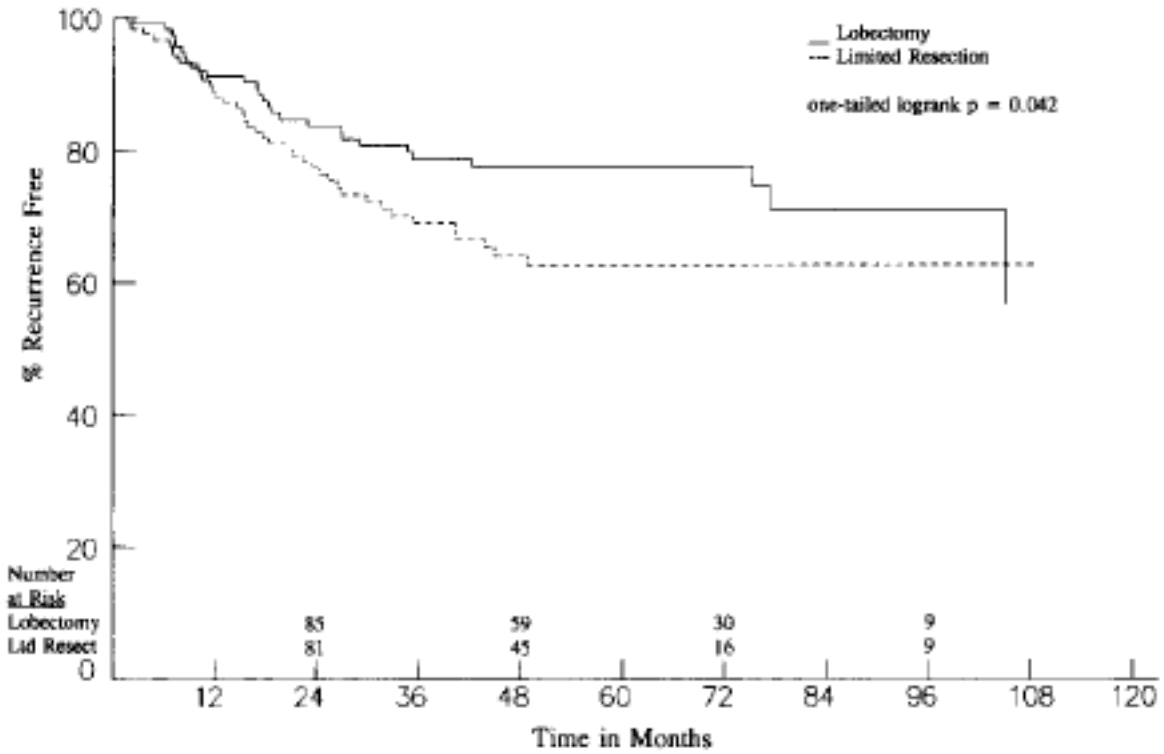
Table 1. Recurrence and Death Rates for the 247 Eligible Patients on LCSG 821 (Revision of Original Table 3)

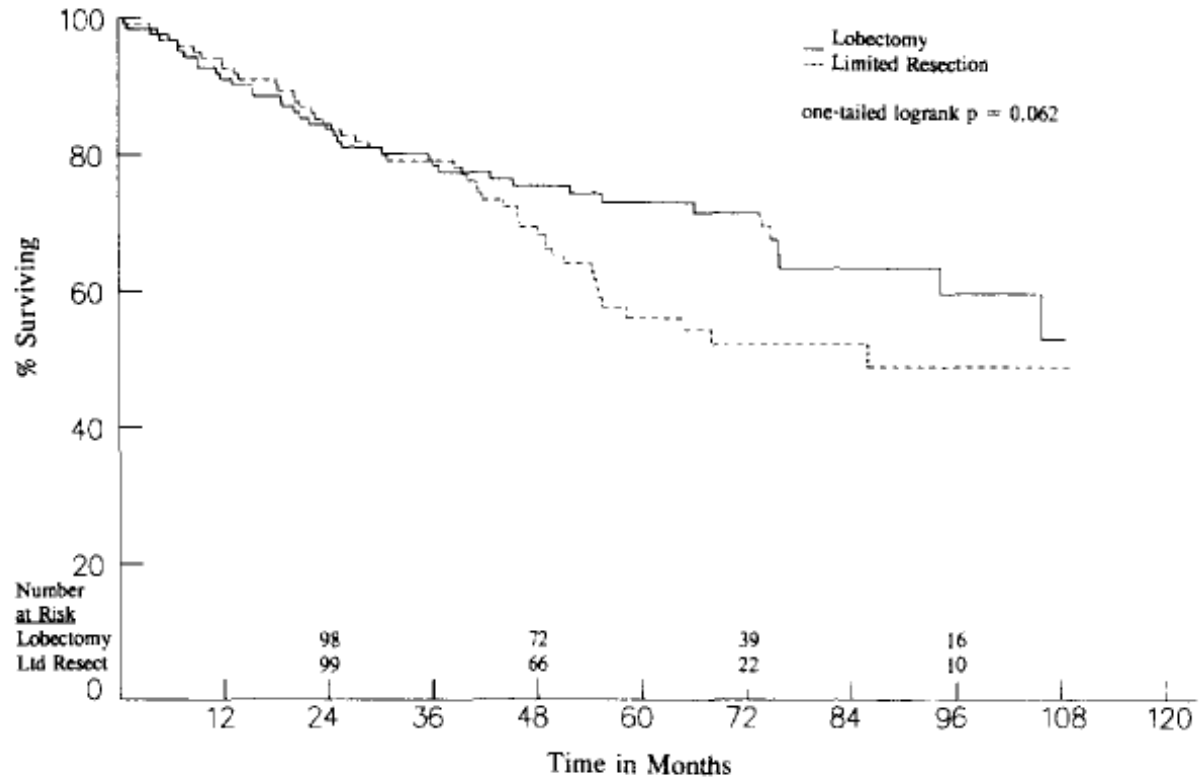
Event	Limited Resection		Lobectomy		
	No. of Patients	Rate (per person/y)	No. of Patients	Rate (per person/y)	*p* Value
Recurrence (excluding second primary)	39	0.094	27	0.058	0.042 1-sided
Recurrence (including second primary)	49	0.118	37	0.079	0.050 1-sided
★ Locoregional recurrence	22	0.054	9	0.019	0.009 2-sided
Nonlocal recurrence	17	0.041	18	0.038	0.98 2-sided
Death (with cancer)	32	0.063	24	0.043	0.107 1-sided
Death (all causes)	49	0.096	38	0.068	0.062 1-sided

★ Locoregional recurrence rate (person/year)

- Lobectomy 0.019
- Segmentectomy 0.040
- Wedge resection 0.084

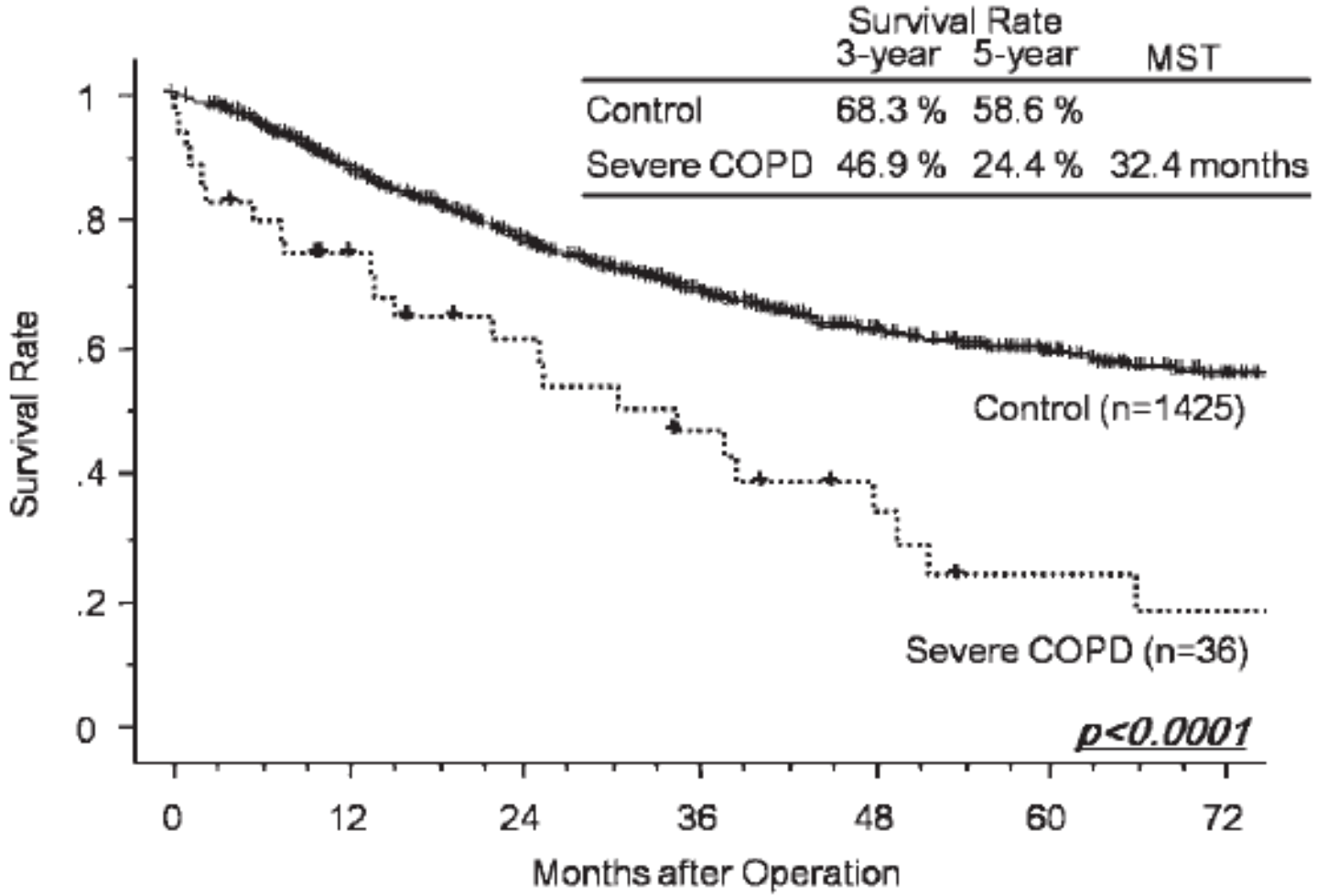
Ann Thorac Surg 1995;60:615-23.
Ann Thorac Surg 1996;62:1249-50.


100
80
60
40
20
0
% Recurrence Free
Lobectomy
Limited Resection
one-tailed logrank p = 0.042
Number at Risk
Lobectomy 85 59 30 9
Lid Resect 81 45 16 9
12 24 36 48 60 72 84 96 108 120
Time in Months


100
80
60
40
20
0
% Surviving
Lobectomy
Limited Resection
one-tailed logrank p = 0.062
Number at Risk
Lobectomy 98 72 39 16
Lid Resect 99 66 22 10
12 24 36 48 60 72 84 96 108 120
Time in Months

Long-term surgical outcome in patients with lung cancer and coexisting severe COPD

Thorac Cardiov Surg 2009;57:339-342.



Risk of Surgery

- Morbidity: 7-33%
- Mortality: 1-3% in lobectomy, 0-1% in segmentectomy

Table 2—*Comparison of Morbidity, Mortality, Local/Regional Recurrence, and Survival Between Lobectomy and Sublobar Resection*

		Lobectomy					Sublobar Resection				
Study	Study Design	No.	Morbidity, %	Mortality, %	Regional Recurrence, %	5-y Survival, %	No.	Morbidity, %	Mortality, %	Regional Recurrence, %	5-y Survival, %
LCSG[4]/1995	Prosp, randomized	122	N/R	1.6	6.4	65	125	N/R	0.8	17	44
Landreneau et al[5]/1997	Prosp, nonrandomized	117	31	3.3	9	68	102	21	0	19.6	58
Koike et al[6]/2003	Prosp, nonrandomized	159	N/R	N/R	1.3	90.1	74	N/R	N/R	2.7	89.1
Martin-Ucar et al[7]/2005	Retrospective, case matched	17	17.6	5.8	12	64	17	17.6	5.8	0	70
Okada et al[8]/2006	Prosp, nonrandomized	305	6.6	N/R	4.9[a]	89.1	262	7.3	0.4	6.9	89.6
Schuchert et al[9]/2007	Retrospective	246	32.4	3.3	4.9	80	182	33.7	1.1	7.7	83

LCSG = Lung Cancer Study Group; N/R = not reported; prosp = prospective.

[a]Local, not further defined.

Short-term outcomes in high-risk stage I lung cancer

Variable	RTOG 0236 (SBRT)	ACOSOG Z4032 (sublobar resection)	ACOSOG Z4033 (RFA)	*P* value*
Patients (n)	55	211	51	
30-d Overall mortality	0	3 (1.4)	1 (2.0)	.6
90-d Overall mortality	0	5 (2.4)	2 (3.9)	.5
Treatment-related mortality	0	0	1 (2.0)	.07
Grade 3+ AEs at 30 d	5 (9.1)	59 (28.0)	NR	.004
Grade 5 AEs at 30 d	0	3 (1.4)	NR	.37
Grade 3+ AEs at 90 d	12 (21.8)	70 (33.2)	14 (27.5)	.24
Grade 5 AEs at 90 d	0	6 (2.8)	2 (3.9)	.38

J Thorac Cardiovasc Surg 2013;145:692-99.

Covariates for pulmonary complications

Variable	OR	95% Confidence limits		p value
DLCO% (10% change)	0.80	0.73	0.89	<0.0001
FEV1% (10% change)	0.91	0.83	0.99	0.035
Female	0.74	0.51	1.08	0.12
Zubrod performance status 0 or 1	1.46	0.92	2.32	0.11
Induction therapy	0.65	0.29	1.46	0.29
No cancer	(ref)			
Early cancer stage (I or II)	0.65	0.40	1.06	0.086
Late cancer stage (III or IV)	0.70	0.38	1.32	0.27
Serum albumin	0.62	0.37	1.03	0.062
Fraction of lung volume preserved	0.39	0.08	1.97	0.26
Year of operation (5 years change)	0.92	0.82	1.03	0.14

Eur J Cardio-Thorac Surg 2008;34:1085-1089.

Covariates for cardiovascular complications

Variable	OR	95% Confidence limits		p value
DLCO% (10% change)	0.94	0.85	1.04	0.21
FEV1% (10% change)	0.87	0.79	0.96	0.0056
Female	0.83	0.57	1.22	0.34
Zubrod performance status 0 or 1	1.23	0.78	1.92	0.38
Induction therapy	1.76	0.92	3.37	0.088
No cancer	(ref)			
Early cancer stage (I or II)	0.75	0.42	1.32	0.31
Late cancer stage (III or IV)	0.98	0.51	1.90	0.96
Serum albumin	0.66	0.43	1.01	0.056
Fraction of lung volume preserved	0.18	0.04	0.82	0.027
Body mass index (BMI)	0.99	0.96	1.03	0.67
Year of operation (5 years change)	0.81	0.72	0.91	0.0004
Age (10 years change)	1.72	1.40	2.10	<0.0001

Eur J Cardio-Thorac Surg 2008;34:1085-1089.

Quantification of emphysema with preoperative computed tomography has stronger association with pulmonary complications than pulmonary function test results after pulmonary lobectomy

J Thorac Cardiovasc Surg 2014;147:915-20

TABLE 3. Risk factor analysis results for pulmonary complications in patients with and without COPD

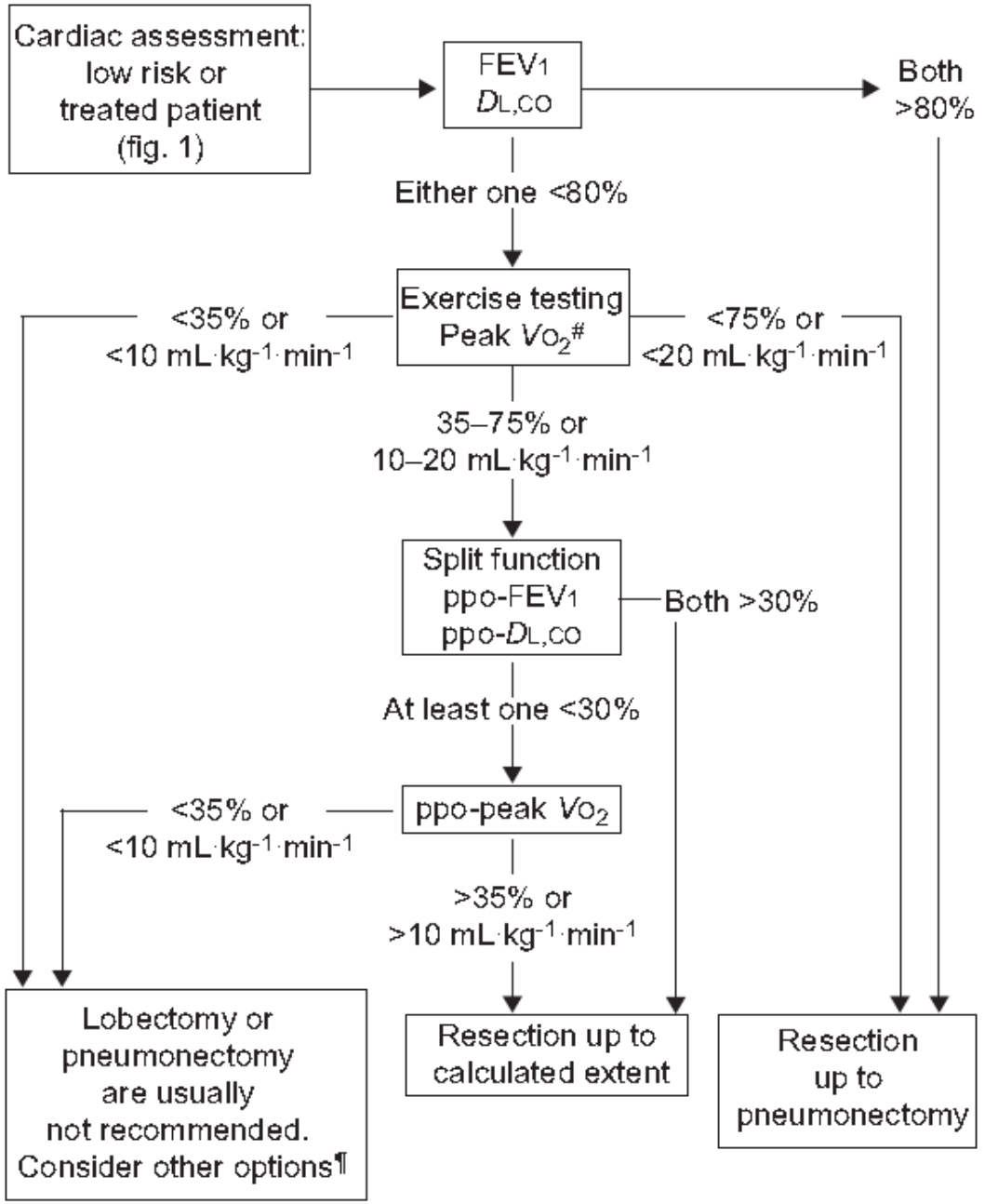
	Patients with COPD				Patients without COPD			
	Univariate		Multivariate		Univariate		Multivariate	
Variable	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value	OR (95% CI)	*P* value
Thoracotomy		.246			4.35 (1.05-18.10)	.062		
Age > 70 y		.682			5.98 (1.51-23.69)	.014	7.63 (1.47-39.60)	.016
Male gender	1.42 (1.25-1.63)	.011			13.97 (1.71-114.43)	.003		
EI		<.001	1.12 (1.05-1.20)	.001		.003	1.17 (1.03-1.31)	.012
FEV_1 < 70%		.551				1.000		
D_LCO < 80%	3.81 (1.50-9.67)	.004	3.84 (1.19-12.40)	.024		.180		
Smoking history		.204			8.31 (1.67-41.47)	.005		
Pulmonary tuberculosis		.552				.284		
Hypertension		.726				.253		
Diabetes mellitus		.527				.518		
Lung cancer		.335				1.000		
Neoadjuvant treatment		1.000				.357		

Patient selection

- FEV1 %
- DLCO
- VO2max
- 6-minute walk test

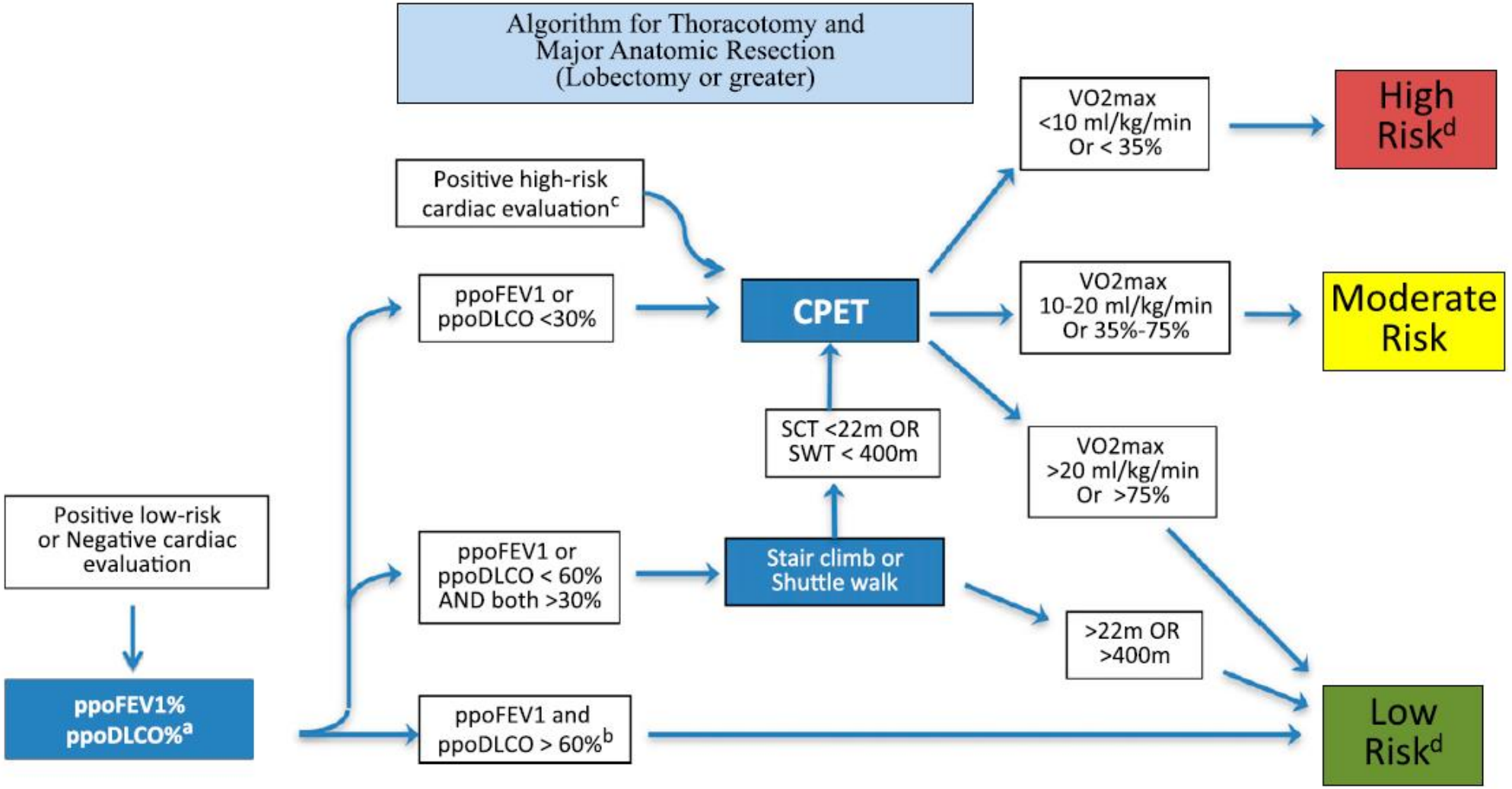
ERS/ESTS

Eur Respir J 2009;34:17-41.



ACCP 3rd

Chest 2013;1439suppl):e166s-190s.

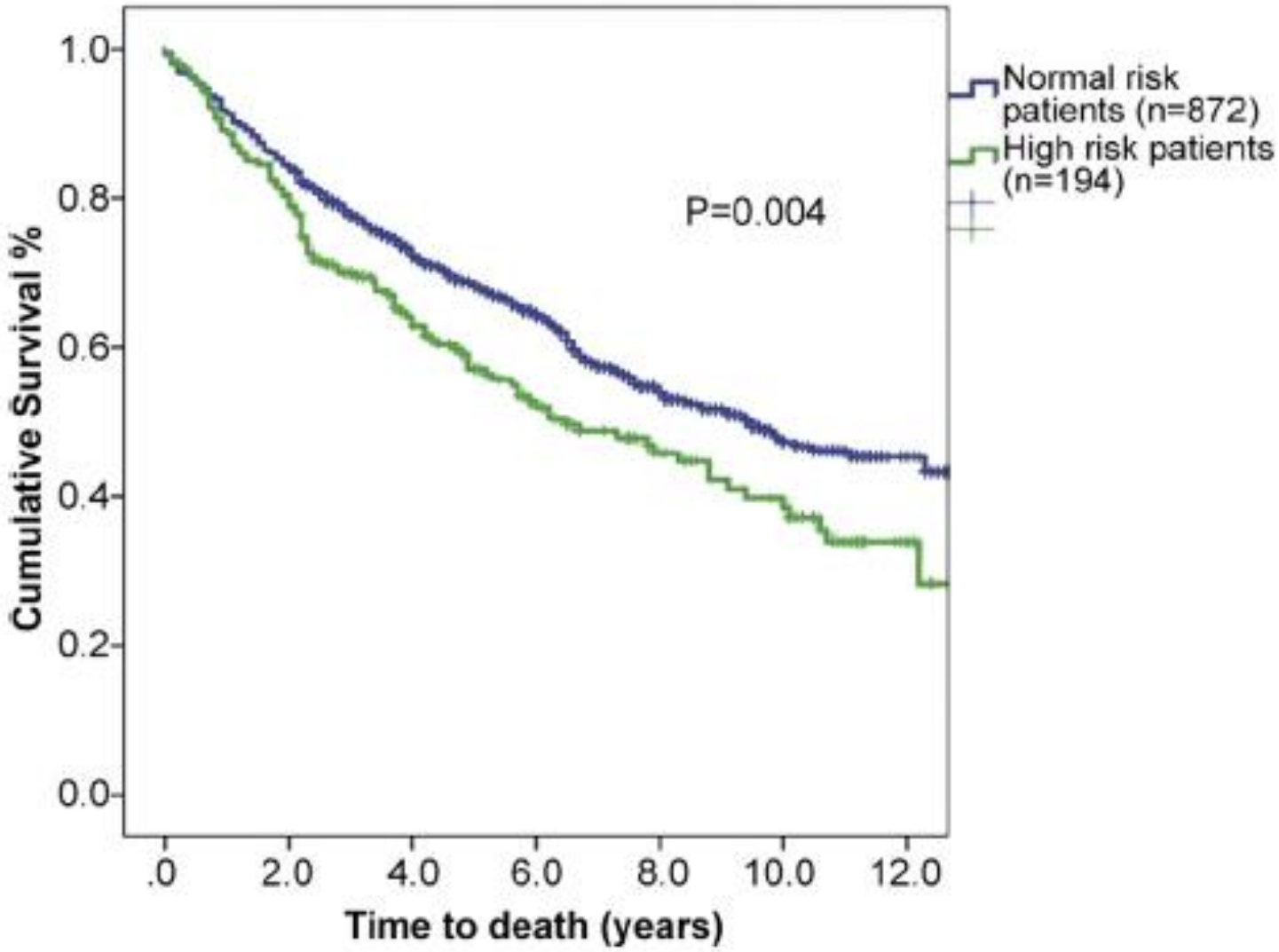


Are they truly “high-risk”?

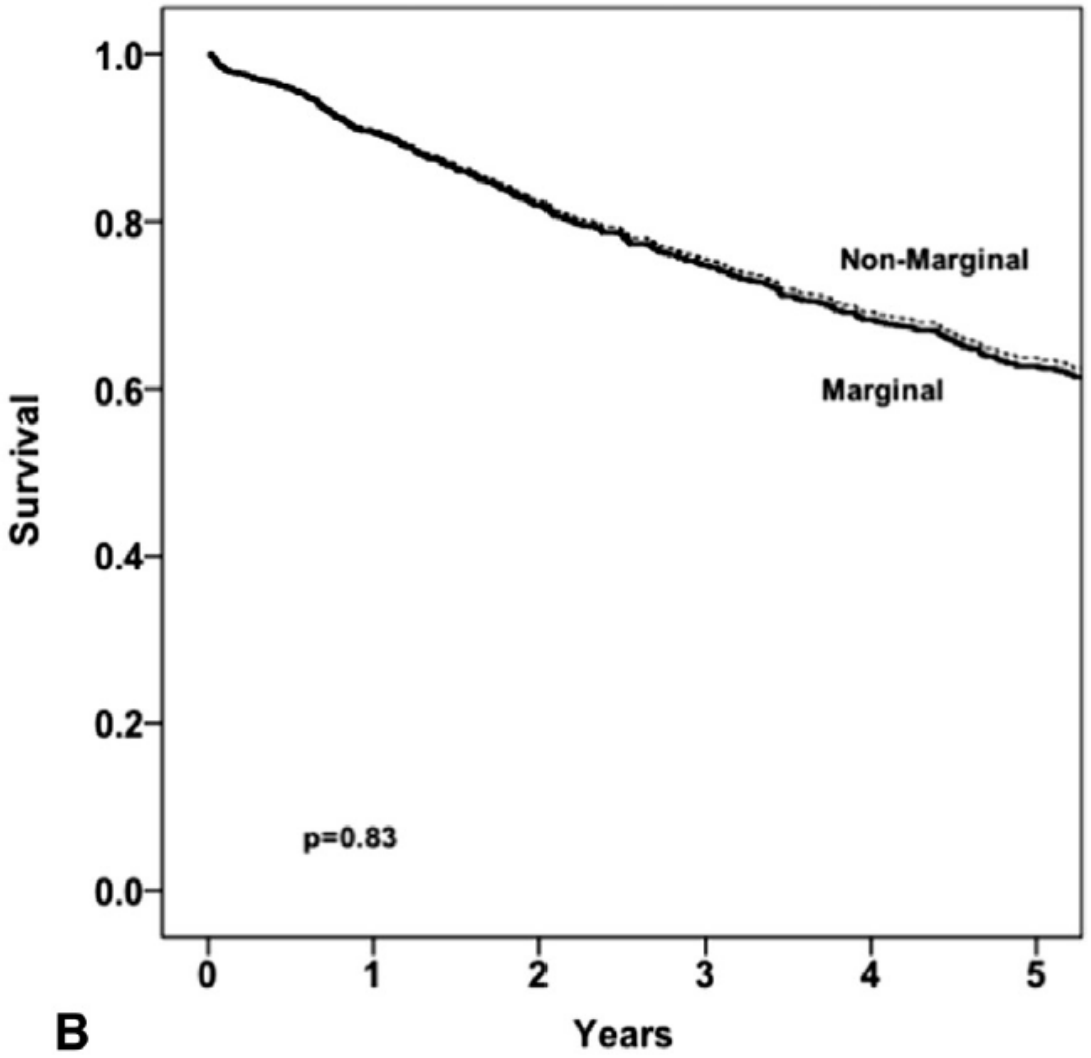
- FEV1 ≤ 50%, D_{LCO} ≤ 50%

	Lobectomy		
Variable[a]	“High-Risk” (n = 117)	“Normal-Risk” (n = 665)	*p* Value
Hospital length of stay, d	7.9 ± 7.8	6.6 ± 6.7	0.05
Respiratory failure	7 (6)	3 (5)	0.65
Pneumonia	5 (4)	40 (6)	0.66
Air leak >5 days	11 (9)	45 (7)	0.33
Empyema	0	2 (0.3)	1.00
Atrial fibrillation	17 (14)	95 (14)	1.00
Hemorrhage requiring reoperation	1 (1)	6 (1)	1.00
Pulmonary embolism	2 (2)	2 (0.3)	0.11
Myocardial infarction	0	4 (0.6)	1.00
Stroke	0	2 (0.3)	1.00
30-day/hospital mortality	2 (2)	12 (2)	1.00

	Sublobar Operation		
Variable[a]	“High-Risk” (n = 72)	“Normal-Risk” (n = 112)	*p* Value
Hospital length of stay, d	4.8 ± 3.3	5.7 ± 11.9	0.53
Respiratory failure	0	1 (1)	1.00
Pneumonia	4 (6)	5 (5)	0.74
Air leak >5 days	5 (7)	5 (5)	0.52
Empyema	1 (1)	1 (1)	1.00
Atrial fibrillation	8 (11)	7 (6)	0.28
Hemorrhage requiring reoperation	1 (1)	1 (1)	1.00
Pulmonary embolism	0	1 (1)	1.00
Myocardial infarction	0	0	—
Stroke	0	1 (1)	1.00
30-day/hospital mortality	0	1 (1)	1.00



Ann Thorac Surg 2014;97:1678-85.



B

At Risk	0	1-year	2-year	3-year	4-year	5-year
Non-Marginal	1128	1051	862	713	542	386
Marginal	131	97	88	71	52	40

FEV1<40% or D_{LCO}< 40%

Thorac Cardiovasc Surg 2014;147:738-46.

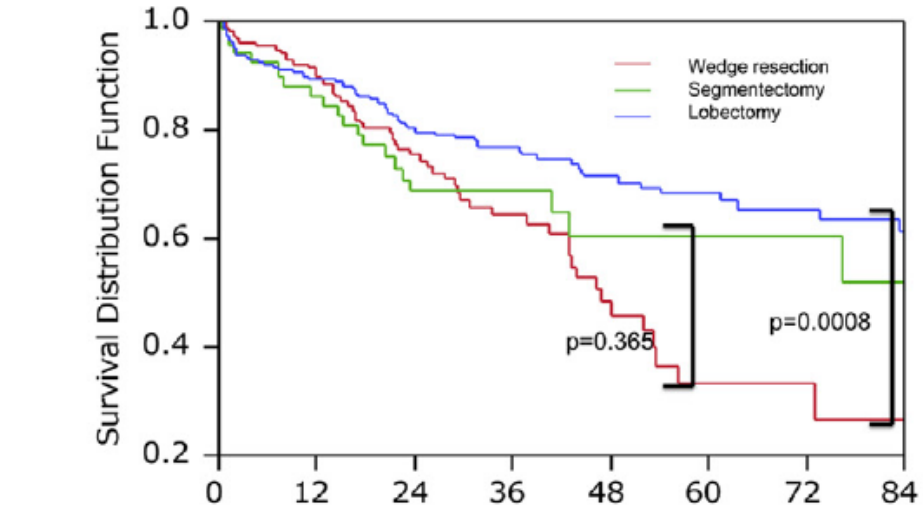
Long-term results and predictors of survival after surgical resection of patients with lung cancer and interstitial lung diseases.

J Thorac Cardiovasc Surg 2015;149:64-70.

TABLE 4. Logistic regression analysis in patients with stage 1A, adjusted for age, sex, and predicted percent of vital capacity

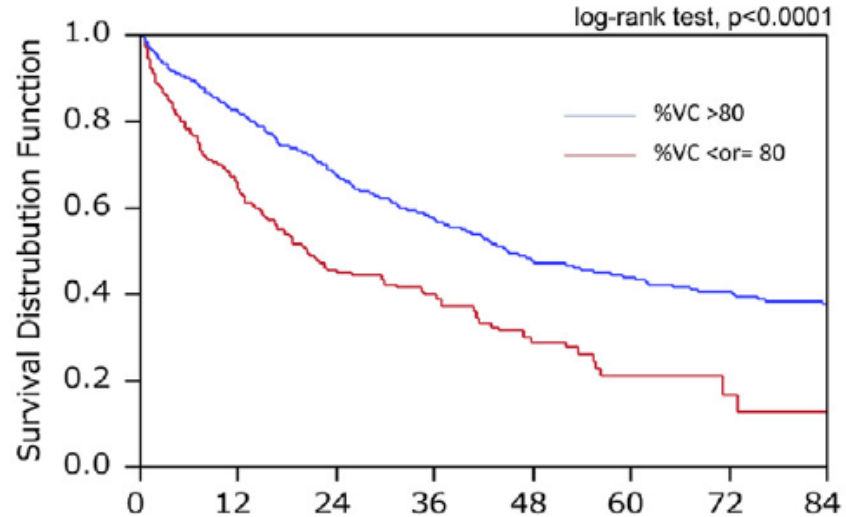
Cause of death	Procedures	Cases (%)	OR	95% CI	*P* value
Cancer	Lobectomy	20/312 (6.4)	1	—	—
	Segmentectomy	12/71 (16.9)	2.56	1.15-5.67	.021
	Wedge resection	26/159 (16.4)	2.98	1.56-5.68	.001
Respiratory failure	Lobectomy	31/312 (9.9)	1	—	—
	Segmentectomy	7/71 (9.9)	0.80	0.32-2.01	.641
	Wedge resection	10/159 (6.3)	0.35	0.15-0.82	.015

CI, Confidence interval; *OR*, odds ratio.



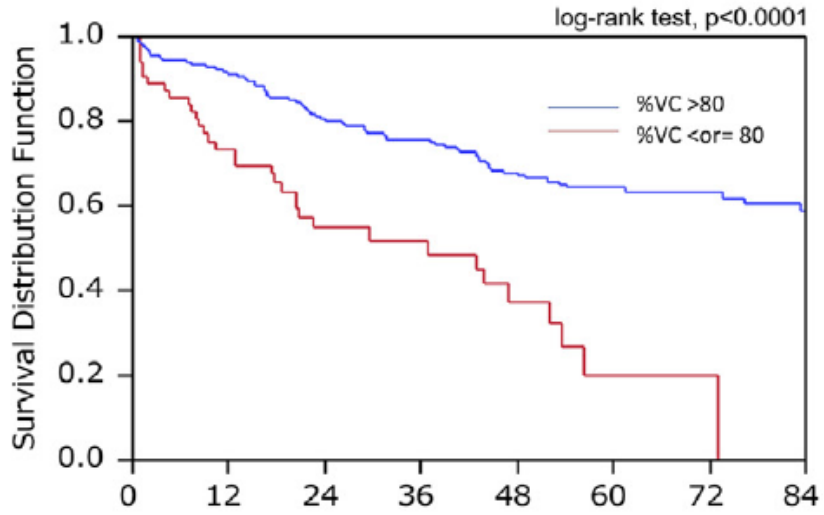
B

Number at risk								
Wedge resection	159	124	74	41	21	8	6	3
Segmentectomy	71	50	32	21	13	11	10	6
Lobectomy	312	246	165	110	80	54	37	24



C

Number at risk								
%VC > 80%	1478	1058	674	413	258	165	109	64
%VC < or =80%	263	141	76	49	25	11	5	4



D

Number at risk								
%VC > 80%	477	379	247	154	103	67	51	31
%VC < or =80%	63	41	23	17	9	4	1	0

- Predicted postoperative FEV1 or DLCO should not be used alone
- No specific cutoff value of pulmonary function
- Multidisciplinary decision

Technique

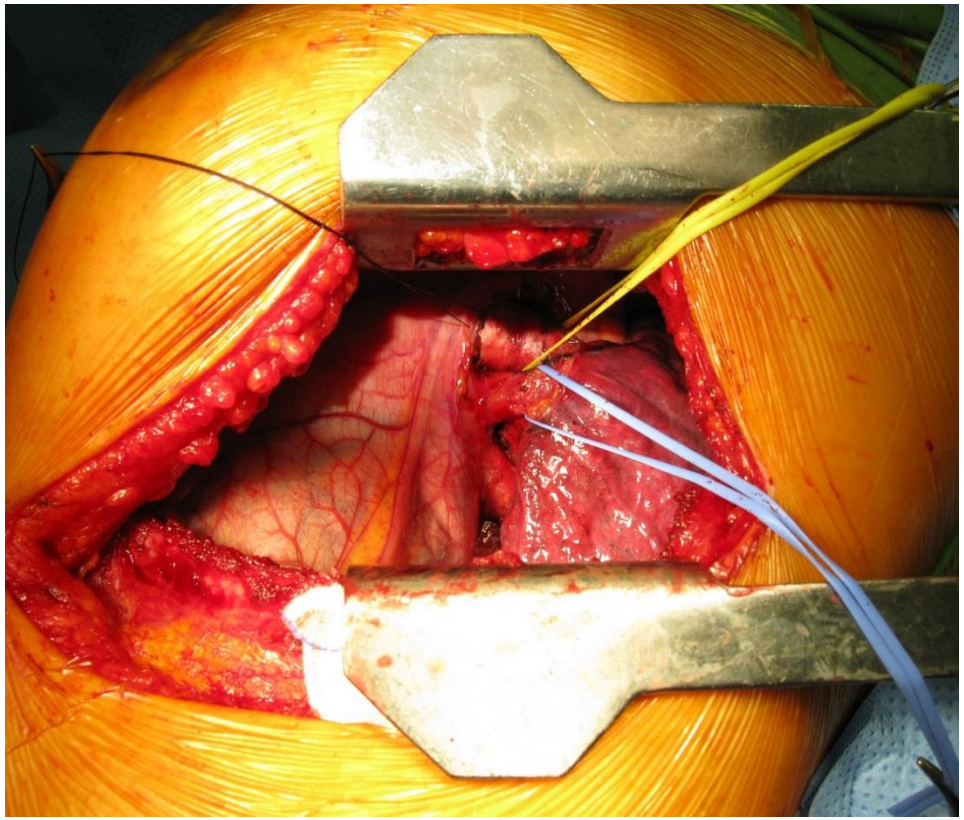
Safety - Less invasive surgery

Minimize Incision

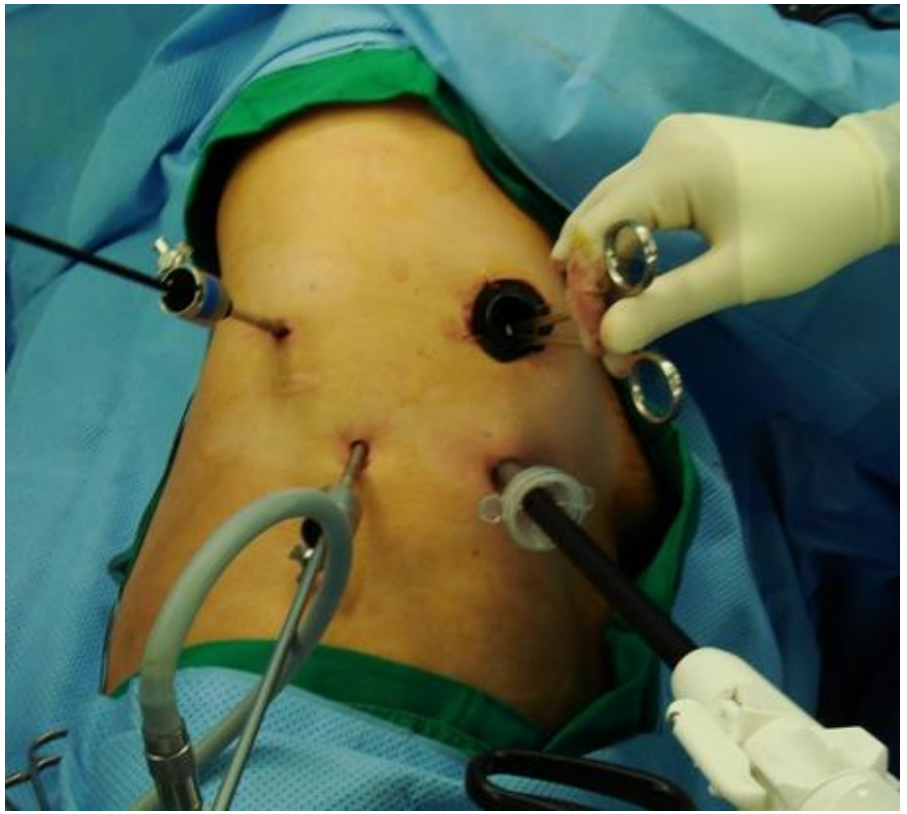
- Minimally invasive surgery

Minimize the lung resection

- Sublobar resection



Open



Minimally Invasive

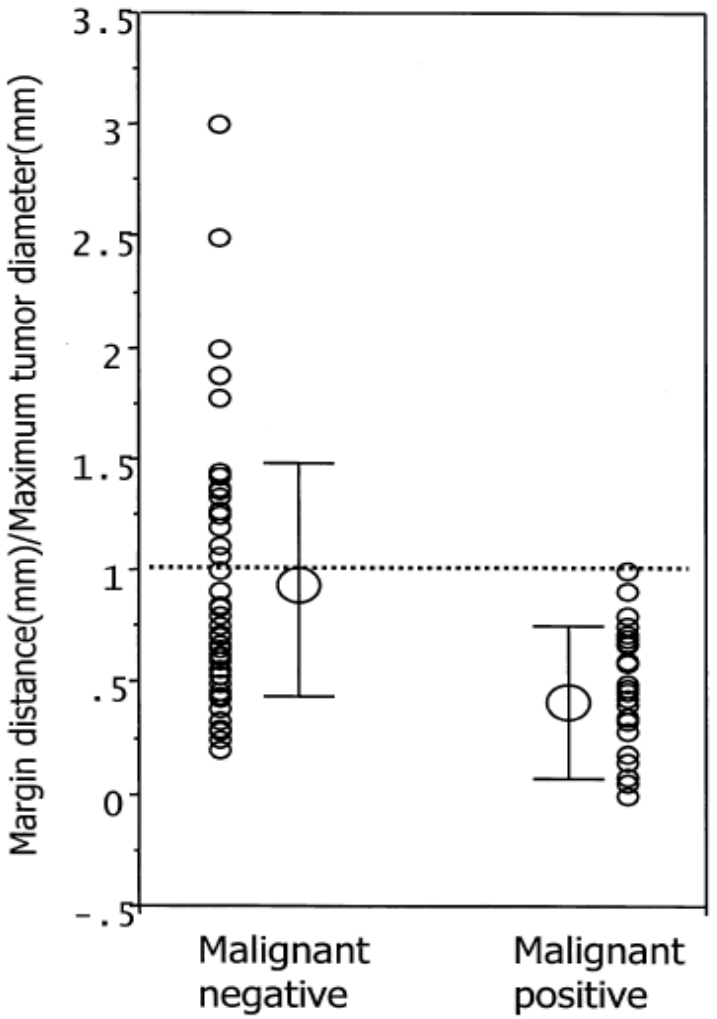
Sublobar Resection of Lung

- Preserve more lung volume

- NCCN guideline
  - Peripheral nodule ≤2cm with
    - AIS
    - GGO ≥ 50%
    - Doubling time ≥ 400 days
- Segmentectomy > Wedge resection

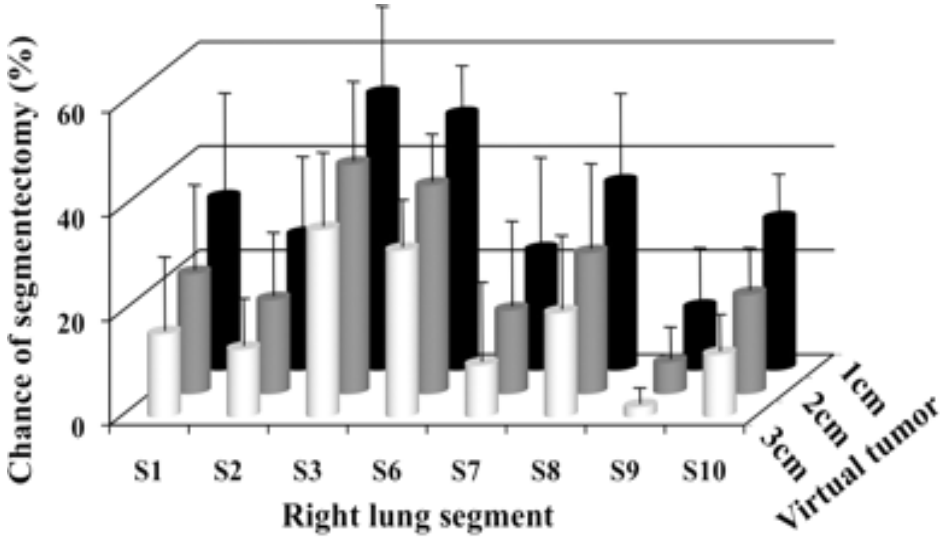
Optimal distance of malignant negative margin in excision of non-small cell lung cancer: A multicenter prospective study

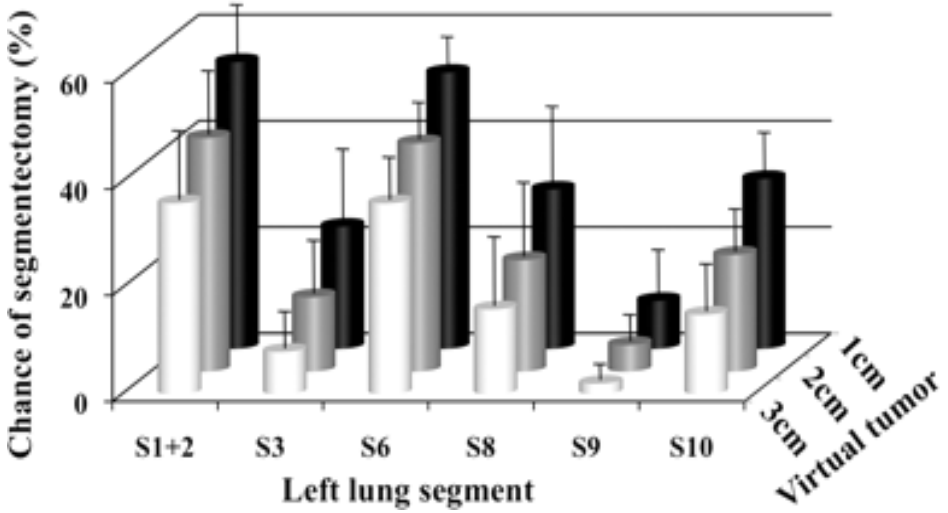
Ann Thorac Sur 2004;77:415-20.

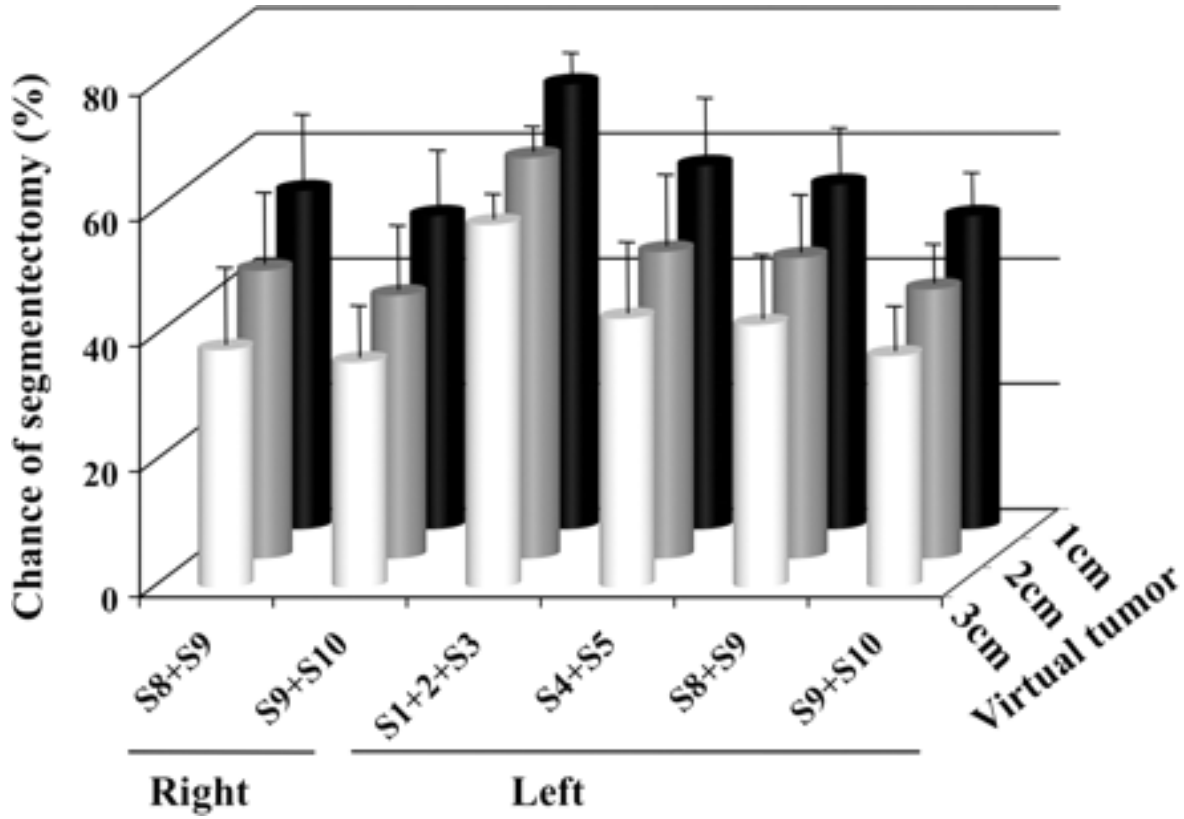


What proportion of lung cancers can be operated by segmentectomy? A computed-tomography-based simulation

Eur J Cardio-thorac Surg 2012;41:341-345.

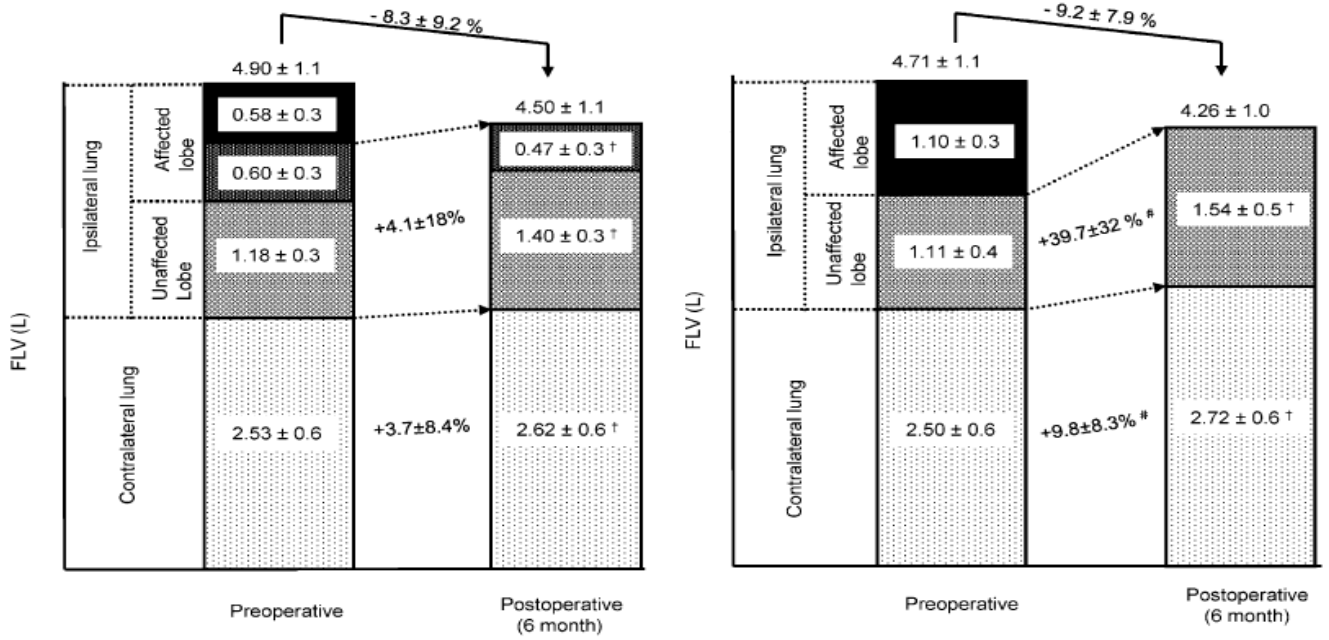




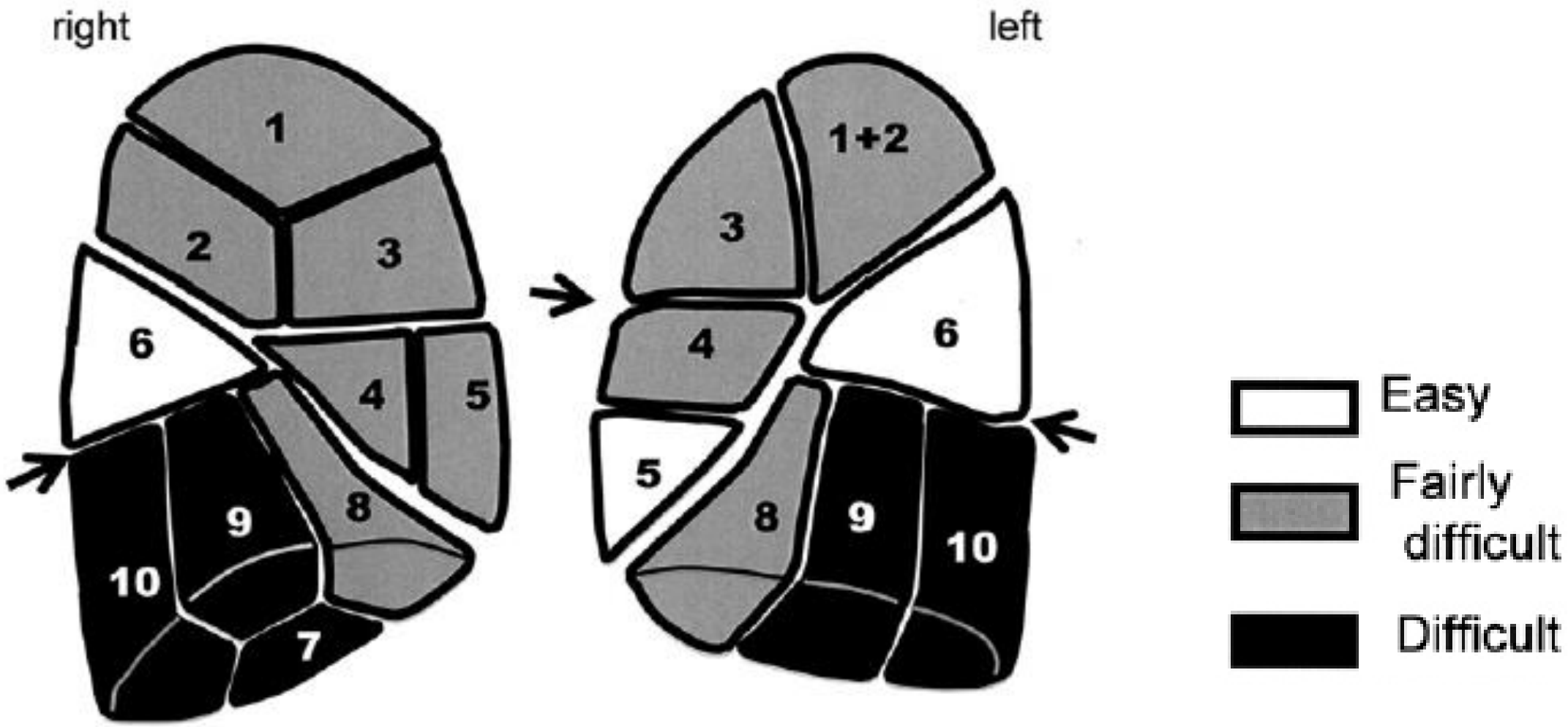


Computed tomography-defined functional lung volume after segmentectomy versus lobectomy

Eur J Cardio-thorac Surg 2010;37:1433-7



Lung volume reduction effect?



J Thorac Cardiovasc Surg 2011;141:678-82.

Division of pulmonary parenchyma

- Dissection of inter-segmental plane

- Stapling of Parenchyma
  - Extended segmentectomy

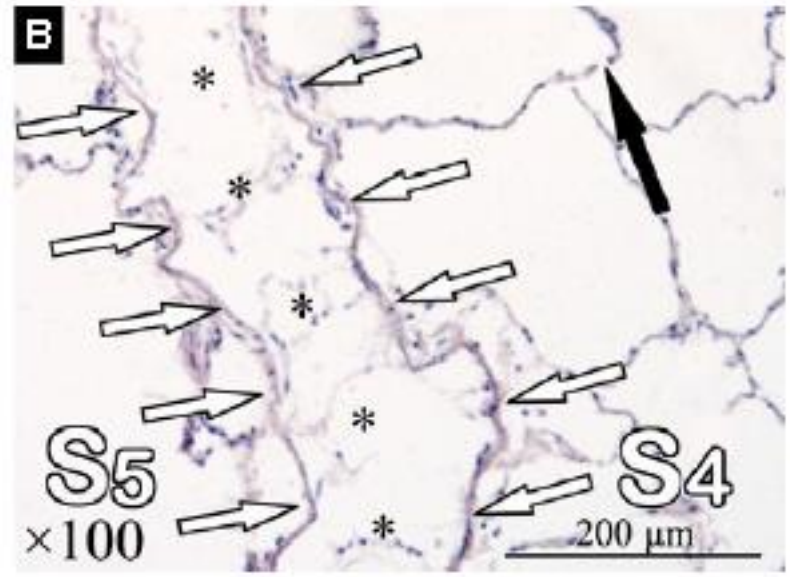
Journal of Anatomy

J. Anat. (2015) 226, pp381–385 doi: 10.1111/joa.12288

Kohn's pores are not responsible for collateral ventilation between inflated and deflated segments: a microscopic study of pulmonary intersegmental septa in the human lung

Yizhi Zuo,[1] Lin Li[1] and Shuwei Liu[2]

[1]*Department of Anatomy, Nanjing Medical University, Nanjing, China*
[2]*Research Centre for Sectional and Imaging Anatomy, Shandong University Sch*



Lymph node dissection

- Accurate staging >> Survival benefit
- Can be minimized in high-risk patients undergoing sublobar resection with minimally invasive approach
- Standard lymph node assessment in case of lobectomy.
  - Systematic lymph node dissection
  - Lobe-specific lymph node dissection
  - Systematic lymph node sampling

Case 1.

Case 2.

Perioperative management

- **Prevention of pulmonary complication**
- Management of cardiac complication
- Management of air-leak

Summary

Lung cancer with poor pulmonary function

- Surgery is beneficial
- Pulmonary function is not the only risk factor
- Multidisciplinary evaluation and management
- Informed decision of patient

Management of Lung Cancer with Cardiac Disease

서울대학교병원 순환기내과

강현재

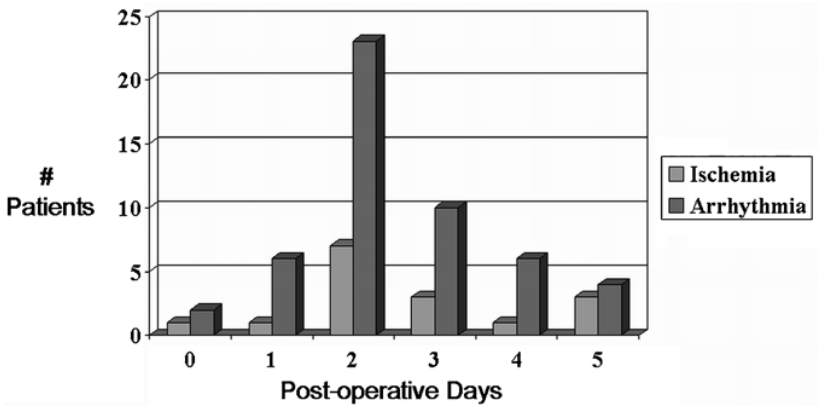
Grocery

- emergency procedure: life or limb is threatened without OP <6h
- urgent procedure: 6-24h
- time-sensitive procedure: 1-6w
- Elective procedure: delayed for up to 1 year

Low-risk: < 1%	Intermediate-risk: 1–5%	High-risk: > 5%
• Superficial surgery • Breast • Dental • Endocrine: thyroid • Eye • Reconstructive • Carotid asymptomatic (CEA or CAS) • Gynaecology: minor • Orthopaedic: minor (meniscectomy) • Urological: minor (transurethral resection of the prostate)	• Intraperitoneal: splenectomy, hiatal hernia repair, cholecystectomy • Carotid symptomatic (CEA or CAS) • Peripheral arterial angioplasty • Endovascular aneurysm repair • Head and neck surgery • Neurological or orthopaedic: major (hip and spine surgery) • Urological or gynaecological: major • Renal transplant • Intra-thoracic: non-major	• Aortic and major vascular surgery • Open lower limb revascularization or amputation or thromboembolectomy • Duodeno-pancreatic surgery • Liver resection, bile duct surgery • Oesophagectomy • Repair of perforated bowel • Adrenal resection • Total cystectomy • Pneumonectomy • Pulmonary or liver transplant

Post-thoracotomy cardiac complications

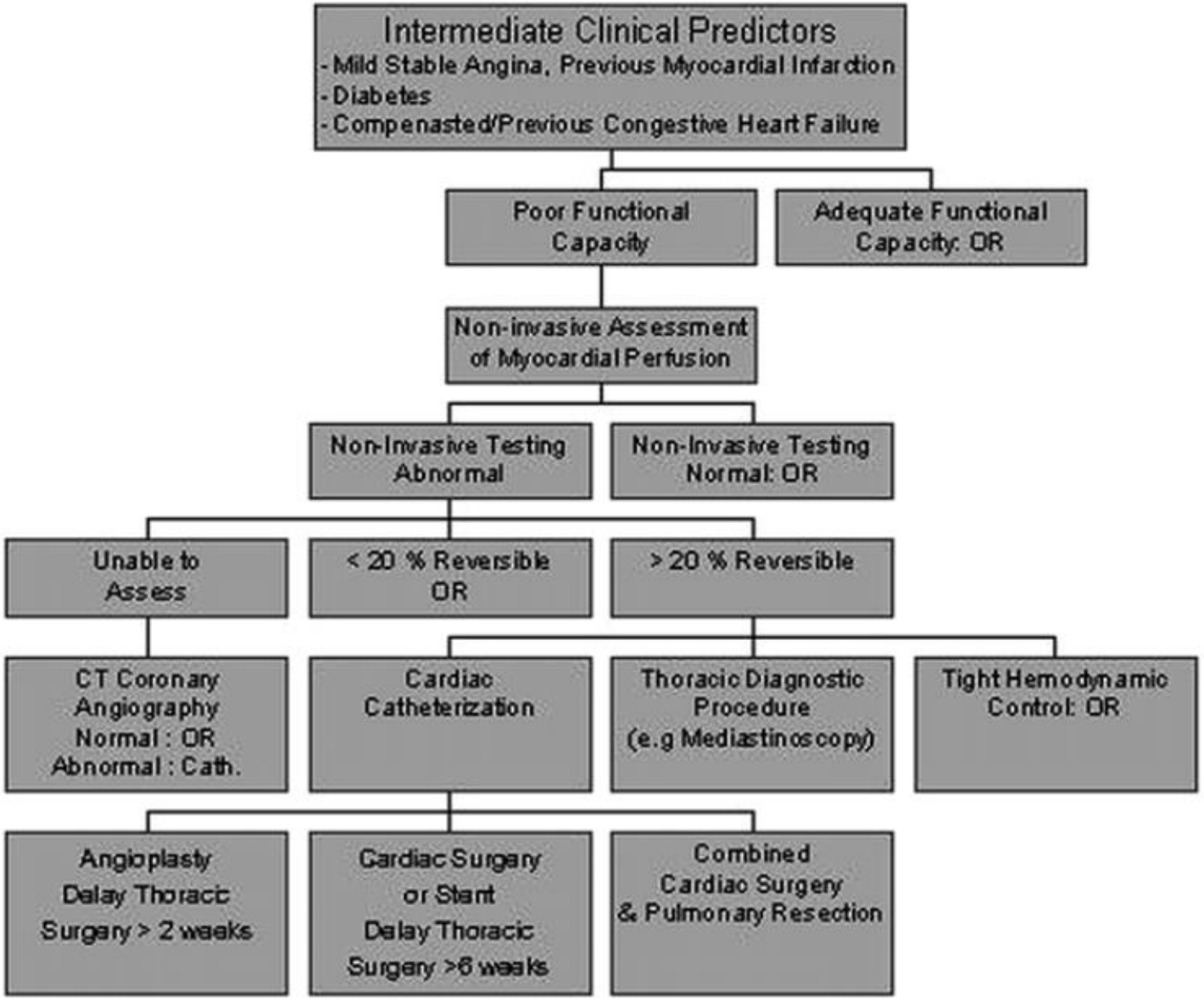
- Post-thoracotomy ischemia: 5%
- Post-lung resection arrhythmia: 30-50%



- 1. Increased flow resistance through the pulmonary vascular bed due to permanent (lung resection) or transient (atelectasis, hypoxemia) causes, with attendant strain on the right side of the heart.
- 2. Increased sympathetic stimuli and oxygen requirements, maximal on the second postoperative day as patients begin to mobilize.

Ann Thorac Surg. 1992;53:642–7.

Cardiac Risk Assessment for Pulmonary Resection



Coronary artery disease

- Angina
- ACS
  - Modifiable by presence and type of coronary revascularization.
  - > 60 days should elapse after a MI before noncardiac surgery
  - recent MI (within 6 months) - an independent risk factor: x 8 → universal definition of recent MI: >30day
- A patient's age
- A history of cerebrovascular disease

Prophylactic revascularization in stable/asymptomatic patients

- Performance of myocardial revascularization is recommended according to the applicable guidelines for management in stable coronary artery disease (I/B)
- Late revascularization after successful non-cardiac surgery should be considered, in accordance with ESC Guidelines on stable coronary artery disease (I/C)
- Prophylactic myocardial revascularization before high-risk surgery may be considered, depending on the extent of a stress-induced perfusion defect. (IIb/B)

2014 ESC/ESA Guidelines

Routine myocardial revascularization in patients with NSTE-ACS

- If non-cardiac surgery can safely be postponed, it is recommended that patients should be diagnosed and treated in line with the guidelines on NSTE-ACS.(I/A)
- In the unlikely combination of a life-threatening clinical condition requiring urgent non-cardiac surgery and revascularization for NSTEACS, the expert team should discuss, case by case, the priority of surgery. (IIa/C)
- In patients who have undergone non-cardiac surgery, aggressive medical treatment and myocardial revascularization according to the guidelines on NSTE-ACS are recommended following surgery. (I/B)
- If PCI is indicated before semi-urgent surgery, the use of new-generation DES, BMS or even balloon angioplasty is recommended. (I/B)

2014 ESC/ESA Guidelines

Heart failure (1)

- At significant risk for perioperative complications
- LVEF
  - the risk of death did not increase notably until LVEF fell below 40%
  - the absolute mortality rate was still high in patients with HF and preserved LVEF as compared with patients without HF
- asymptomatic left ventricular (LV) dysfunction on perioperative outcomes is unknown

Heart failure (2)

- It should be noted that the 2011 appropriate use criteria for echocardiography states it is “inappropriate” to assess ventricular function in patients without signs or symptoms of cardiovascular disease in the preoperative setting
- Measurement of biomarkers, especially natriuretic peptides, may be helpful in assessing patients with HF and with diagnosing HF as a postoperative complication in patients at high risk for HF

Recommendations on heart failure (1)

- It is recommended that patients with established or suspected heart failure, and who are scheduled for noncardiac intermediate or high-risk surgery, undergo evaluation of LV function with transthoracic echocardiography and/or assessment of natriuretic peptides, unless they have recently been assessed for these. (I/A)
- It is recommended that patients with established heart failure, who are scheduled for intermediate or high risk non-cardiac surgery, be therapeutically optimized as necessary, using beta-blockers, ACEIs or ARBs, and mineralocorticoid antagonists and diuretics, according to ESC Guidelines for heart failure treatment. (I/A)
- In patients with newly diagnosed heart failure, it is recommended that intermediate- or high-risk surgery be deferred, preferably for at least 3 months after initiation of heart failure therapy, to allow time for therapy up-titration and possible improvement of LV function. (I/C)

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Recommendations on heart failure (2)

- It is recommended that beta blockade be continued in heart failure patients throughout the peri-operative period, whereas ACEIs/ARBs may be omitted on the morning of surgery, taking into consideration the patient’s blood pressure. If ACEIs/ARBs are given, it is important to carefully monitor the patient's haemodynamic status and give appropriate volume replacement when necessary. (I/C)
- Unless there is adequate time for dose-titration, initiation of high-dose beta-blockade before non-cardiac surgery in patients with heart failure is not recommended. (III/B)

2014 ESC/ESA Guidelines

Arterial hypertension

Recommendations	Class[a]	Level[b]	Ref.[c]
It is recommended that patients with a new diagnosis of hypertension pre-operatively be screened for end-organ damage and cardiovascular risk factors.	I	C	
Large peri-operative fluctuations in blood pressure in hypertensive patients should be avoided.	IIa	B	187
Clinicians may consider *not* deferring non-cardiac surgery in patients with grade 1 or 2 hypertension (systolic blood pressure <180 mm Hg; diastolic blood pressure <110 mm Hg).	IIb	B	182

2014 ESC/ESA Guidelines

Cardiomyopathy

- Restrictive Cardiomyopathies
  - Cardiac output in these cardiomyopathies with restrictive physiology is both preload and heart rate dependent. Significant reduction of blood volume or filling pressures, bradycardia or tachycardia, and atrial arrhythmias such as AF/atrial flutter may not be well tolerated.
- Hypertrophic Obstructive Cardiomyopathy
  - decreased systemic vascular resistance (arterial vasodilators), volume loss, or reduction in preload or LV filling may increase the degree of dynamic obstruction and further decrease diastolic filling and cardiac output
  - Overdiuresis should be avoided, and inotropic agents are usually not used in these patients because of increased LV outflow gradient.

Valvular Heart Disease (1)

CLASS I

1. It is recommended that patients with clinically suspected moderate or greater degrees of valvular stenosis or regurgitation undergo preoperative echocardiography if there has been either 1) no prior echocardiography within 1 year or 2) a significant change in clinical status or physical examination since last evaluation. (Level of Evidence: C)

2. For adults who meet standard indications for valvular intervention (replacement and repair) on the basis of symptoms and severity of stenosis or regurgitation, valvular intervention before elective noncardiac surgery is effective in reducing perioperative risk. (Level of Evidence: C)

2014 ACC/AHA Guideline

Valvular Heart Disease (2)

- The risk of noncardiac surgery can be minimized by 1) having an accurate diagnosis of the type and severity of valvular heart disease, 2) choosing an anesthetic approach appropriate to the valvular heart disease, and 3) considering a higher level of perioperative monitoring (e.g., arterial pressure, pulmonary artery pressure, transesophageal echocardiography), as well as managing the patient postoperatively in an intensive care unit setting.

Aortic Stenosis (1)

CLASS IIa

- Elevated-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable to perform in patients with asymptomatic severe aortic stenosis. (Level of Evidence: B)

2014 ACC/AHA Guideline

CLASS I

- Aortic valve replacement is recommended in symptomatic patients with severe aortic stenosis, who are scheduled for elective non-cardiac surgery, provided that they are not at high risk of an adverse outcome from for valvular surgery. (Level of Evidence: B)

CLASS IIa

- Aortic valve replacement should be considered in asymptomatic patients with severe aortic stenosis, who are scheduled for elective high-risk non-cardiac surgery, provided that they are not at high risk of an adverse outcome from for valvular surgery. (Level of Evidence: C)
- Elective low or intermediate-risk noncardiac surgery should be considered in asymptomatic patients with severe aortic stenosis if there has been no previous intervention on the aortic valve. (Level of Evidence: C)
- In symptomatic patients with severe aortic stenosis who are scheduled for elective non-cardiac surgery, TAVI or balloon aortic valvuloplasty should be considered by the expert team if they are at high risk of an adverse outcome from for valvular surgery. (Level of Evidence: C)

2014 ESC/ESA Guidelines

Aortic Stenosis (2)

- The mechanism of MACE in patients with AS likely arises from the anesthetic agents and surgical stress that lead to an unfavorable hemodynamic state (hypotension and tachycardia)
- Inoperable high risk AS: invasive hemodynamic monitoring and optimization of loading conditions, percutaneous aortic balloon dilation as a bridging strategy, and transcatheter aortic valve replacement. - no data for the efficacy or safety of TAVR for patients with AS who are undergoing noncardiac surgery.

Mitral Stenosis

CLASS IIb

1. Elevated-risk elective noncardiac surgery using appropriate intraoperative and postoperative hemodynamic monitoring may be reasonable in asymptomatic patients with severe mitral stenosis if valve morphology is not favorable for percutaneous mitral balloon commissurotomy. (Level of Evidence: C)

- The main goals during the perioperative period are to monitor intravascular volume and to avoid tachycardia and hypotension: maintain CO without increase in LAP

2014 ACC/AHA Guideline

Aortic and Mitral Regurgitation (1)

CLASS IIa

1. Elevated-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable in adults with asymptomatic severe MR. (Level of Evidence: C)
2. Elevated-risk elective noncardiac surgery with appropriate intraoperative and postoperative hemodynamic monitoring is reasonable in adults with asymptomatic severe aortic regurgitation (AR) and a normal LVEF. (Level of Evidence: C)

2014 ACC/AHA Guideline

Aortic and Mitral Regurgitation (2)

- Left-sided regurgitant lesions convey increased cardiac risk during noncardiac surgery but are better tolerated than stenotic valvular disease.
- To optimize forward cardiac output during anesthesia and surgery

  1) preload should be maintained because the LV has increased size and compliance

  2) excessive systemic afterload should be avoided so as to augment cardiac output and reduce the regurgitation volume.
- Patients should/could be monitored with invasive hemodynamics and echocardiography and admitted postoperatively to an intensive care unit setting when undergoing surgical procedures with elevated risk.

Arrhythmias and Conduction Disorders (1)

- Patients with a preoperative history of AF who are clinically stable generally do not require modification of medical management or special evaluation in the perioperative period, other than adjustment of anticoagulation
- The potential for perioperative formation of left atrial thrombus in patients with persistent AF may need to be considered if the operation involves physical manipulation of the heart, as in certain thoracic procedures.

Arrhythmias and Conduction Disorders (2)

- Although frequent ventricular premature beats and nonsustained ventricular tachycardia are risk factors for the development of intraoperative and postoperative arrhythmias, they are not associated with an increased risk of nonfatal MI or cardiac death in the perioperative period.
- However, patients who develop sustained or nonsustained ventricular tachycardia during the perioperative period may require referral to a cardiologist for further evaluation, including assessment of their ventricular function and screening for CAD.
- Isolated bundle-branch block and bifascicular block generally do not contraindicate use of beta blockers.

Cardiovascular Implantable Electronic Devices (1)

CLASS I

1. Before elective surgery in a patient with a CIED, the surgical/procedure team and clinician following the CIED should communicate in advance to plan perioperative management of the CIED. (Level of Evidence: C)

- American Society of Anesthesiologists jointly developed an expert consensus statement published in July 2011 and endorsed by the ACC and the AHA (33). a single recommendation for all patients with CIEDs is not appropriate

2014 ACC/AHA Guideline

Cardiovascular Implantable Electronic Devices (2)

- perioperative CIED interrogation or reprogramming (including changing pacing to an asynchronous mode and/or inactivating ICD tachytherapies), application of a magnet over the CIED with or without postoperative CIED interrogation, or use of no perioperative CIED interro
- Details of individual prescriptions will depend on the nature and location of the operative procedure, likelihood of use of monopolar electrocautery, type of CIED (i.e., pacemaker versus ICD), and dependence of the patient on cardiac pacing.gation or intervention

General principles

- Inactivation of ICD detection is *not* a universal requirement for all procedures.
- Rendering PMs asynchronous in pacemaker-dependent patients is *not* a universal requirement of all procedures.
- Pacemakers that need to be protected from inhibition may be made asynchronous by programming or by placement of a magnet applied over the pulse generator, provided the pulse generator is accessible.
- ICD arrhythmia detection can be suspended by placement of a magnet over the pulse generator, provided the pulse generator is accessible.
- A magnet placed over an ICD generator will not render pacemaker function in an ICD asynchronous.
- Inactivation of ICD detection is recommended for all procedures using monopolar electrosurgery or RF ablation above the umbilicus.
- Rendering a PM asynchronous in a PM-dependent patient is preferable for most procedures above the umbilicus.
- In pacemaker patients, no reprogramming is usually needed if the electrosurgery is applied below the level of the umbilicus.

Essential elements for cardiologist

- Type of procedure
- Anatomic location of surgical procedure
- Patient position during the procedure
- Will monopolar electrosurgery be used?
- Will other sources of EMI likely be present?
- Will cardioversion or defibrillation be used?
- Surgical venue (operating room, procedure suite, etc)
- Anticipated postprocedural arrangements
- Unusual circumstances: cardiothoracic or chest wall surgical procedure that could impair/damage or encroach upon the CIED leads, anticipated large blood loss, operation in close proximity to CIED

Essential elements for the operative team

• Date of last device interrogation

• Type of device—pacemaker, ICD, CRT-D, CRT-P, ILR, implantable hemodynamic monitor

• Manufacturer and model

• Indication for device:

- Pacemaker: e.g., sick sinus syndrome, AV block, syncope

- ICD: primary or secondary prevention

- Cardiac resynchronization therapy

• Battery longevity documented as 3 months

• Are any of the leads less than 3 months old?

• Programming

- Pacing mode and programmed lower rate

- ICD therapy

- Lowest heart rate for shock delivery

- Lowest heart rate for ATP delivery

- Rate-responsive sensor type, if programmed on

• Is the patient pacemaker dependent, and what is the underlying rhythm and heart rate if it can be determined?

• What is the response of this device to magnet placement?

- Magnet pacing rate for a PM

- Pacing amplitude response to magnet function

- Will ICD detections resume automatically with removal of the magnet? Does this device allow for magnet application function to be disabled? If so, document programming of patient's device for this feature

• Any alert status on CIED generator or lead

• Last pacing threshold—document adequate safety margin with the date of that threshold

EMERGENCY PROTOCOL

- PACEMAKER
  - All pacemaker-dependent CIED patients should be monitored by plethysmography or by an arterial line and with transcutaneous pacing pads placed in the anterior/posterior position.
  - Use short electrosurgical bursts
  - Magnet ready
- ICD
  - a magnet placed over an ICD generator will not protect the patient from EMI pacing inhibition
  - short electrosurgical bursts (less than 5 seconds) are recommended
  - The only way to render a patient with an ICD to asynchronous pacing is to reprogram the ICD, as a magnet renders a defibrillator unable to treat tachyarrhythmias, but it does not change the pacing mode.
  - During deactivation of ICD, continuous cardiac monitoring is mandatory.

Pulmonary Vascular Disease

CLASS I

1. Chronic pulmonary vascular targeted therapy should be continued unless contraindicated or not tolerated in patients with pulmonary hypertension who are undergoing noncardiac surgery. (Level of Evidence: C)

CLASS IIa

1. Unless the risks of delay outweigh the potential benefits, preoperative evaluation by a pulmonary hypertension specialist before noncardiac surgery can be beneficial for patients with pulmonary hypertension, particularly for those with features of increased perioperative risk. (Level of Evidence: C)

2014 ACC/AHA Guideline

PAH and pulmonary disease

Recommendations	Class[a]	Level[b]
It is recommended that patients with severe PAH, who are undergoing elective surgery, be managed in a centre with appropriate expertise.	I	C
It is recommended that interventions for high-risk patients with PAH be planned by the multidisciplinary pulmonary hypertension team.	I	C
It is recommended that patients with PAH have an optimized treatment regimen before any non-emergency surgical intervention.	I	C
It is recommended that patients receiving PAH-specific treatment continue this in the pre-, peri-, and post-operative period without interruption.	I	C
It is recommended that monitoring of patients with PAH continue for at least 24 hours in the post-operative period.	I	C
In the case of progression of right heart failure in the post-operative period of patients with PAH, it is recommended that the diuretic dose be optimized and, if necessary, intravenous vasoactive drugs be initiated under the guidance of a physician experienced in the management of PAH.	I	C
In patients with COPD, smoking cessation (>2 months before surgery) is recommended before undertaking surgery.	I	C
In the case of severe right heart failure that is not responsive to supportive therapy, the temporary administration of pulmonary vasodilators (inhaled and/or intravenous) is recommended, under the guidance of a physician experienced in PAH.	I	C
In patients at high risk of OHS additional specialist investigation before major elective surgery should be considered.	IIa	C

2014 ESC/ESA Guidelines

Multivariate Risk Indices

CLASS IIa

1. A validated risk-prediction tool can be useful in predicting the risk of perioperative MACE in patients undergoing noncardiac surgery. (Level of Evidence: B)

CLASS III: NO BENEFIT

1. For patients with a low risk of perioperative MACE, further testing is not recommended before the planned operation. (Level of Evidence: B)

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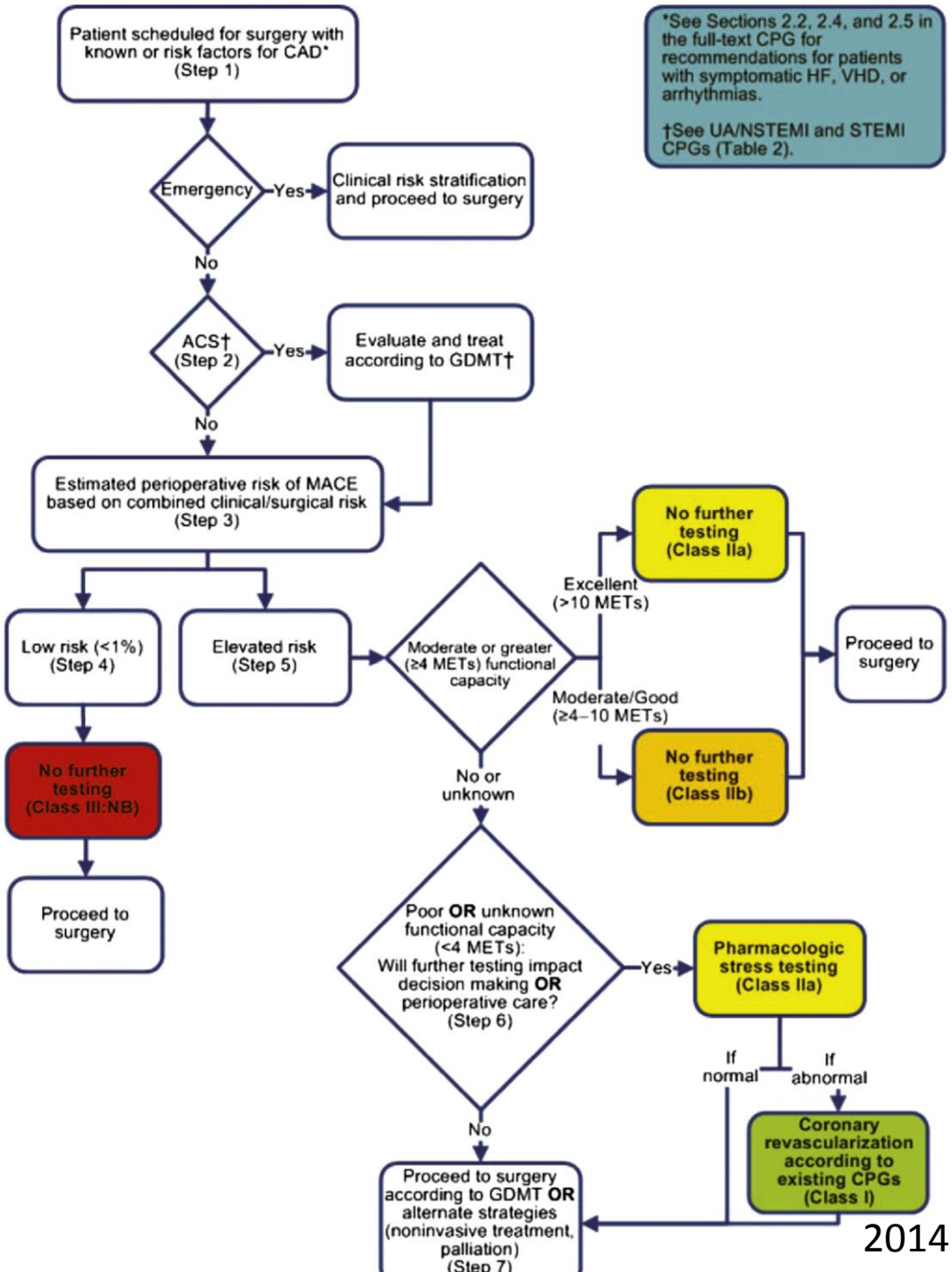
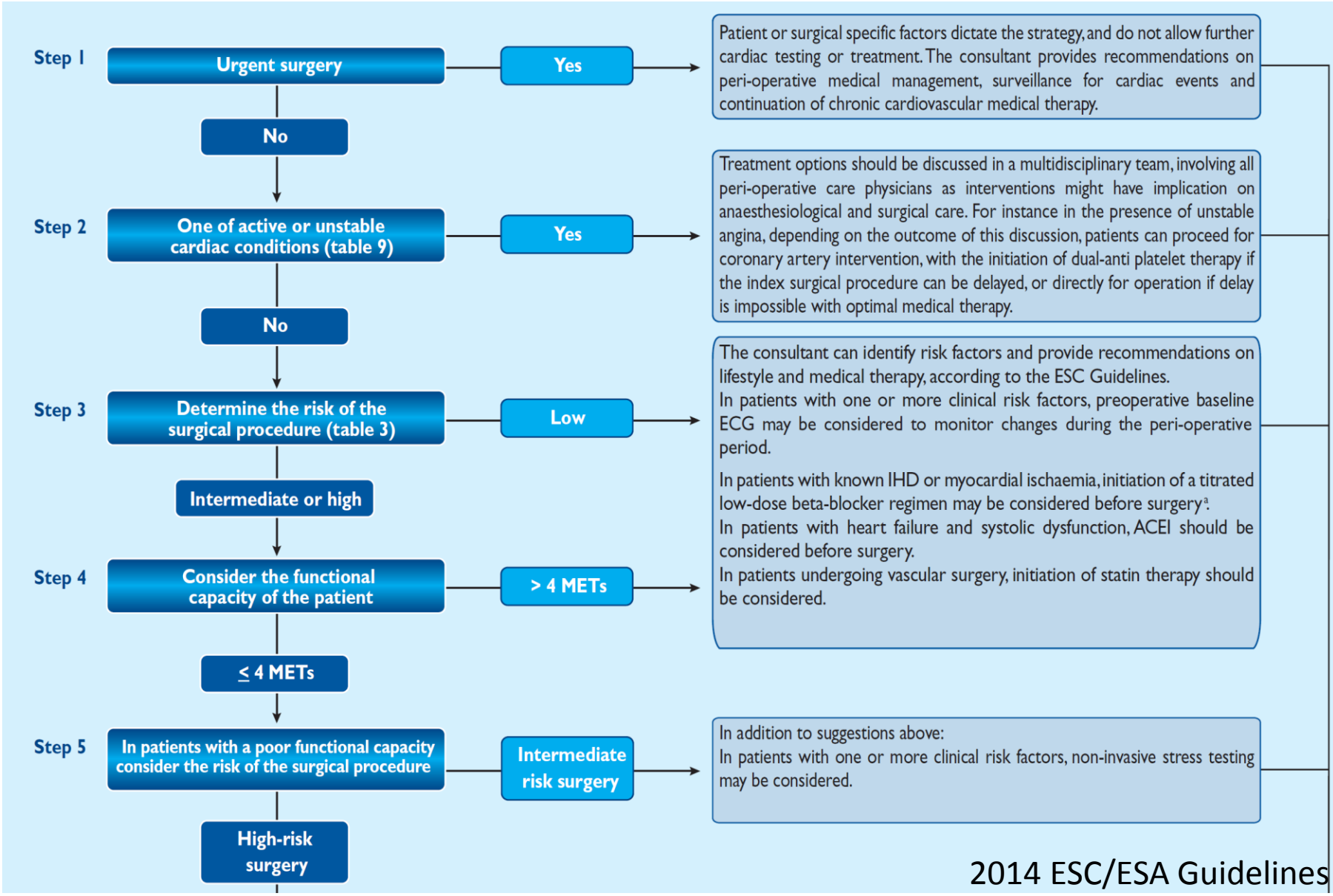
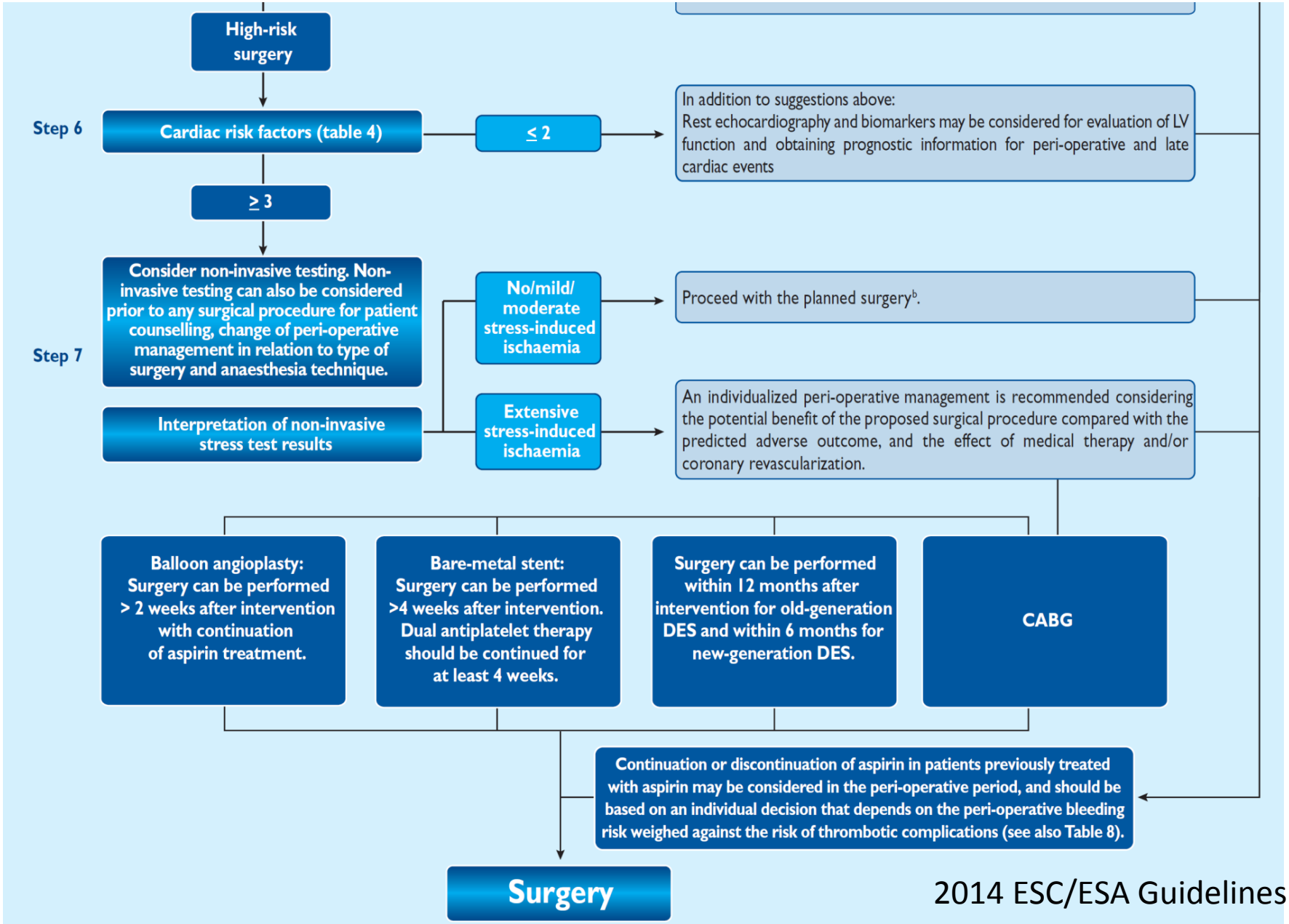
	RCRI (131)	American College of Surgeons NSQIP MICA (115)	American College of Surgeons NSQIP Surgical Risk Calculator (114)
Criteria	...	Increasing age	Age
	Creatinine ≥2 mg/dL	Creatinine >1.5 mg/dL	Acute renal failure
	HF	...	HF
	...	Partially or completely dependent functional status	Functional status
	Insulin-dependent diabetes mellitus	...	Diabetes mellitus
	Intrathoracic, intra-abdominal, or suprainguinal vascular surgery	Surgery type: • Anorectal • Aortic • Bariatric • Brain • Breast • Cardiac • ENT • Foregut/hepatopancreatobiliary • Gallbladder/adrenal/appendix/spleen • Intestinal • Neck • Obstetric/gynecological • Orthopedic • Other abdomen • Peripheral vascular • Skin • Spine • Thoracic • Vein • Urologic	Procedure (CPT Code)
	History of cerebrovascular accident or TIA	...	...
	...	...	American Society of Anesthesiologists Physical Status Class
	...	...	Wound class
	...	...	Ascites
	...	...	Systemic sepsis
	...	...	Ventilator dependent
	...	...	Disseminated cancer
	...	...	Steroid use
	...	...	Hypertension
	Ischemic heart disease	...	Previous cardiac event
	...	...	Sex
	...	...	Dyspnea
	...	...	Smoker
	...	...	COPD
	...	...	Dialysis
	...	...	Acute kidney injury
	...	...	BMI
	...	...	Emergency case



2014 ACC/AHA Guideline



2014 ESC/ESA Guidelines



2014 ESC/ESA Guidelines

Recommendations	COR	LOE
The 12-lead ECG		
Preoperative resting 12-lead ECG is reasonable for patients with known coronary heart disease or other significant structural heart disease, except for low-risk surgery	IIa	B
Preoperative resting 12-lead ECG may be considered for asymptomatic patients, except for low-risk surgery	IIb	B
Routine preoperative resting 12-lead ECG is not useful for asymptomatic patients undergoing low-risk surgical procedures	III: No Benefit	B
Assessment of LV function		
It is reasonable for patients with dyspnea of unknown origin to undergo preoperative evaluation of LV function	IIa	C
It is reasonable for patients with HF with worsening dyspnea or other change in clinical status to undergo preoperative evaluation of LV function	IIa	C
Reassessment of LV function in clinically stable patients may be considered	IIb	C
Routine preoperative evaluation of LV function is not recommended	III: No Benefit	B
Exercise stress testing for myocardial ischemia and functional capacity		
For patients with elevated risk and excellent functional capacity, it is reasonable to forgo further exercise testing and proceed to surgery	IIa	B
For patients with elevated risk and unknown functional capacity it may be reasonable to perform exercise testing to assess for functional capacity if it will change management	IIb	B
For patients with elevated risk and moderate to good functional capacity, it may be reasonable to forgo further exercise testing and proceed to surgery	IIb	B
For patients with elevated risk and poor or unknown functional capacity it may be reasonable to perform exercise testing with cardiac imaging to assess for myocardial ischemia	IIb	C
Routine screening with noninvasive stress testing is not useful for low-risk noncardiac surgery	III: No Benefit	B
Cardiopulmonary exercise testing		
Cardiopulmonary exercise testing may be considered for patients undergoing elevated risk procedures	IIb	B
Noninvasive pharmacological stress testing before noncardiac surgery		
It is reasonable for patients at elevated risk for noncardiac surgery with poor functional capacity to undergo either DSE or MPI if it will change management	IIa	B
Routine screening with noninvasive stress testing is not useful for low-risk noncardiac surgery	III: No Benefit	B
Preoperative coronary angiography		
Routine preoperative coronary angiography is not recommended	III: No Benefit	C

2014 ACC/AHA Guideline

Recommendations	COR	LOE
Coronary revascularization before noncardiac surgery		
Revascularization before noncardiac surgery is recommended when indicated by existing CPGs	I	C
Coronary revascularization is not recommended before noncardiac surgery exclusively to reduce perioperative cardiac events	III: No Benefit	B
Timing of elective noncardiac surgery in patients with previous PCI		
Noncardiac surgery should be delayed after PCI	I	C: 14 d after balloon angioplasty B: 30 d after BMS implantation
Noncardiac surgery should optimally be delayed 365 d after DES implantation	I	B
A consensus decision as to the relative risks of discontinuation or continuation of antiplatelet therapy can be useful	IIa	C
Elective noncardiac surgery after DES implantation may be considered after 180 d	IIb*	B
Elective noncardiac surgery should not be performed in patients in whom DAPT will need to be discontinued perioperatively within 30 d after BMS implantation or within 12 mo after DES implantation	III: Harm	B
Elective noncardiac surgery should not be performed within 14 d of balloon angioplasty in patients in whom aspirin will need to be discontinued perioperatively	III: Harm	C
Perioperative beta-blocker therapy		
Continue beta blockers in patients who are on beta blockers chronically	I	B SR†
Guide management of beta blockers after surgery by clinical circumstances	IIa	B SR†
In patients with intermediate- or high-risk preoperative tests, it may be reasonable to begin beta blockers	IIb	C SR†
In patients with ≥3 RCRI factors, it may be reasonable to begin beta blockers before surgery	IIb	B SR†
Initiating beta blockers in the perioperative setting as an approach to reduce perioperative risk is of uncertain benefit in those with a long-term indication but no other RCRI risk factors	IIb	B SR†
It may be reasonable to begin perioperative beta blockers long enough in advance to assess safety and tolerability, preferably >1 d before surgery	IIb	B SR†
Beta-blocker therapy should not be started on the d of surgery	III: Harm	B SR†
Perioperative statin therapy		
Continue statins in patients currently taking statins	I	B
Perioperative initiation of statin use is reasonable in patients undergoing vascular surgery	IIa	B
Perioperative initiation of statins may be considered in patients with a clinical risk factor who are undergoing elevated-risk procedures	IIb	C

2014 ACC/AHA Guideline

Alpha-2 agonists		
Alpha-2 agonists are not recommended for prevention of cardiac events	III: No Benefit	B
ACE inhibitors		
Continuation of ACE inhibitors or ARBs is reasonable perioperatively	IIa	B
If ACE inhibitors or ARBs are held before surgery, it is reasonable to restart as soon as clinically feasible postoperatively	IIa	C
Antiplatelet agents		
Continue DAPT in patients undergoing urgent noncardiac surgery during the first 4 to 6 wk after BMS or DES implantation, unless the risk of bleeding outweighs the benefit of stent thrombosis prevention	I	C
In patients with stents undergoing surgery that requires discontinuation $P2Y_{12}$ inhibitors, continue aspirin and restart the $P2Y_{12}$ platelet receptor–inhibitor as soon as possible after surgery	I	C
Management of perioperative antiplatelet therapy should be determined by consensus of treating clinicians and the patient	I	C
In patients undergoing nonemergency/nonurgent noncardiac surgery without prior coronary stenting, it may be reasonable to continue aspirin when the risk of increased cardiac events outweighs the risk of increased bleeding	IIb	B
Initiation or continuation of aspirin is not beneficial in patients undergoing elective noncardiac noncarotid surgery who have not had previous coronary stenting	III: No Benefit	B C: If risk of ischemic events outweighs risk of surgical bleeding
Perioperative management of patients with CIEDs		
Patients with ICDs should be on a cardiac monitor continuously during the entire period of inactivation, and external defibrillation equipment should be available. Ensure that ICDs are reprogrammed to active therapy	I	C

2014 ACC/AHA Guideline

anti-platelet therapy

CLASS I (LOE: C)

- It is recommended that aspirin be continued for 4 weeks after BMS implantation and for 3–12 months after DES implantation, unless the risk of life-threatening surgical bleeding on aspirin is unacceptably high.

CLASS IIa (LOE:C)

P2Y12

CLASS IIb (LOE:C)

- In patients treated with P2Y12 inhibitors, who need to undergo surgery, postponing surgery for at least 5 days after cessation of ticagrelor and clopidogrel—and for 7 days in the case of prasugrel—if clinically feasible, should be considered unless the patient is at high risk of an ischaemic event.

2014 ESC/ESA Guidelines

NOAC

	Dabigatran	Rivaroxaban	Apixaban	Edoxaban
Target	IIa (thrombin)	Xa	Xa	Xa
Application	Oral	Oral	Oral	Oral
Hours to C^{max}	1.25–3	2–4	3–4	1–2
Pro-drug	Yes	No	No	No
Food interactions	No	No	No	No
Bioavailability (%)	6.5	80–100	50	62
Drug interactions	P gp inhibitors or inductors	CYP3a4 inhibitors or inductors P gp inhibitors or inductors	CYP3a4 inhibitors or inductors P gp inhibitors or inductors	P gp inhibitors
Median half-life (hours)	12–14	7-11 (11–13 in the elderly)	12	6-11
Renal clearance (%)	85	33	27	37-50
Dose regimen	b.i.d.	q.d.	b.i.d.	q.d

Conversion: warfarin - NOAC

Conversion from warfarin to a NOAC

Patients who are stably anticoagulated on warfarin may prefer to remain on warfarin. However, the added convenience and thepotential for enhanced efficacy and reduced risk for intracranialbleeding of Dabigatran,Rivaroxaban or Apixaban, may mean that many patients will choose totransition from warfarin to one of the new anticoagulants[7].

- For conversion from warfarin to a NOAC (Dabigatran,Rivaroxaban or Apixaban), discontinue warfarin and start NOAC the next day when INR is 2.3 or less.

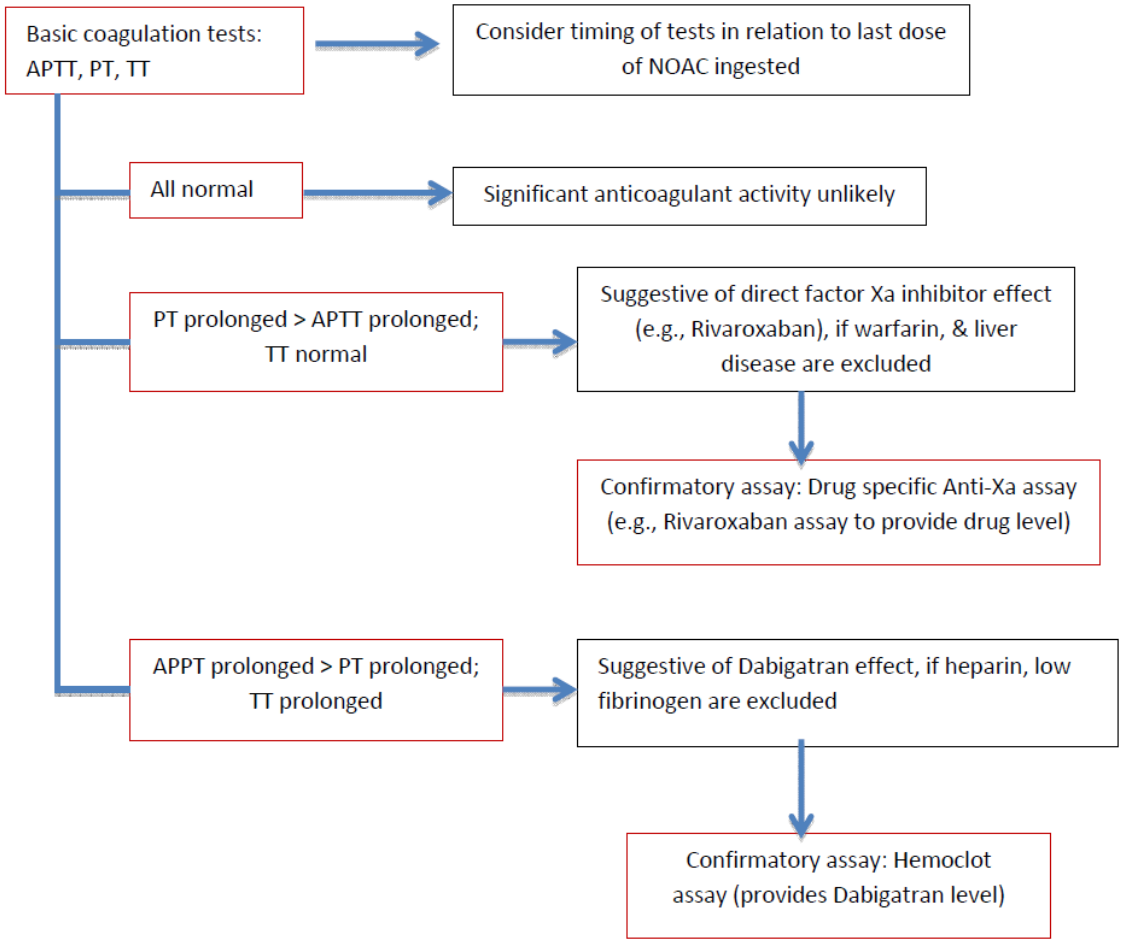
Conversion from a NOAC to warfarin

Stop the NOAC when INR has been ≥2.0 on two consecutive days

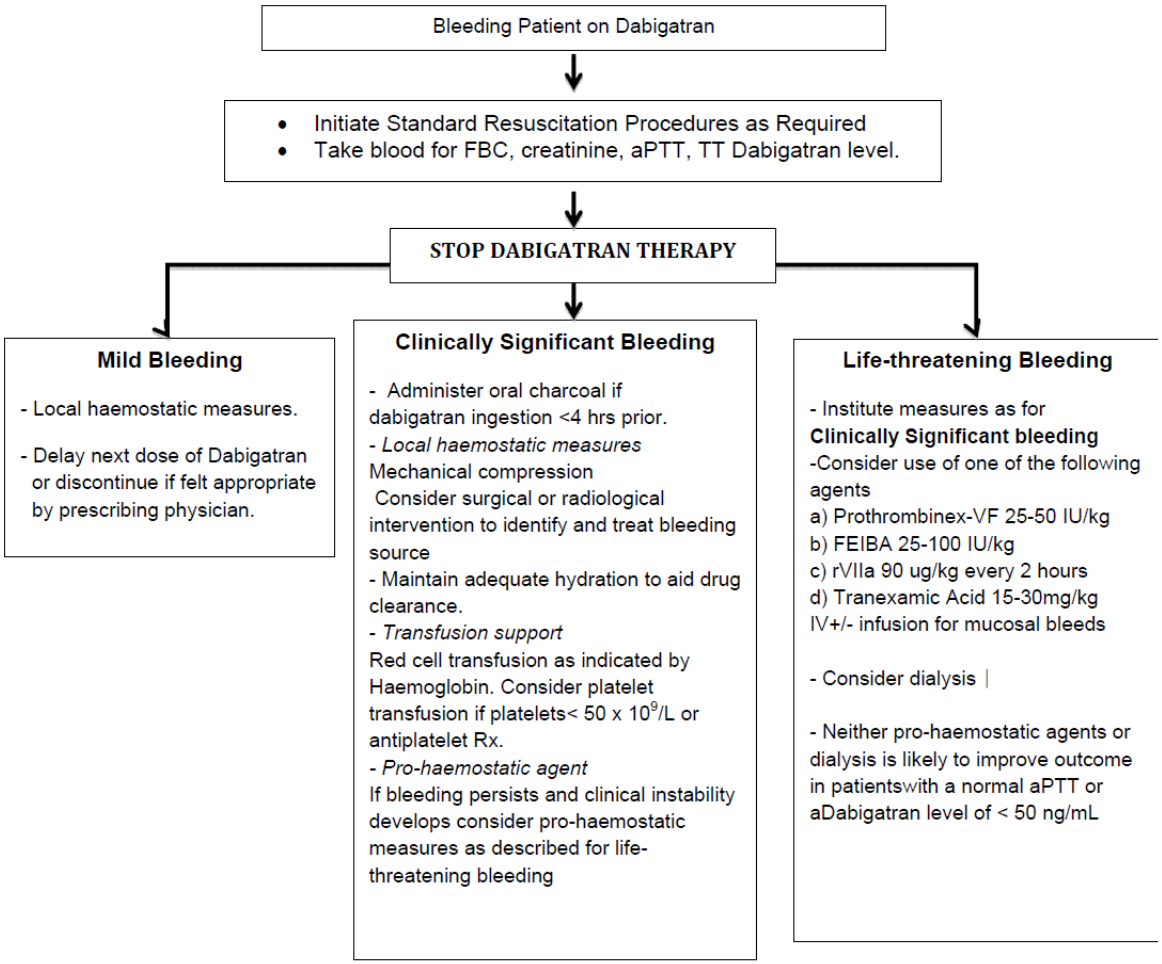
Coagulation test for NOACs

Novel oral anticoagulant	Prothrombin time (PT)	Activated partial thromboplastin time (aPTT)	Thrombin clotting time (TCT)	Ecarin clotting time	Hemoclot assay	Anti-factor Xa activity	
						Clot-based	Chromogenic
Dabigatran	↑ or NC (low sensitivity, varies with reagent)	↑ (varies with reagent)	↑	↑	↑[a]	–	–
Rivaroxaban	↑ or NC (not sensitive at low concentrations, varies with reagent)	↑ or NC (less sensitive than PT)	–	–	–	↑	↑[a]
Apixaban	↑ or NC (limited sensitivity, may vary with reagent)	↑ or NC (limited sensitivity, may vary with reagent)	–	–	–	↑[a]	↑[a]
Edoxaban	↑ (may vary with reagent)	↑ (may vary with reagent)	–	–	–	↑	↑[a]

[a] Indicates preferred test. Adapted from previously published review articles [30, 65]



Pathology 2013; **45**(4): 435-7


Bleeding Patient on Dabigatran
• Initiate Standard Resuscitation Procedures as Required
• Take blood for FBC, creatinine, aPTT, TT Dabigatran level.
STOP DABIGATRAN THERAPY
Mild Bleeding
- Local haemostatic measures.
- Delay next dose of Dabigatran or discontinue if felt appropriate by prescribing physician.
Clinically Significant Bleeding
- Administer oral charcoal if dabigatran ingestion <4 hrs prior.
- Local haemostatic measures
Mechanical compression
Consider surgical or radiological intervention to identify and treat bleeding source
- Maintain adequate hydration to aid drug clearance.
- Transfusion support
Red cell transfusion as indicated by Haemoglobin. Consider platelet transfusion if platelets< 50 x 10^9/L or antiplatelet Rx.
- Pro-haemostatic agent
If bleeding persists and clinical instability develops consider pro-haemostatic measures as described for life-threatening bleeding
Life-threatening Bleeding
- Institute measures as for Clinically Significant bleeding
-Consider use of one of the following agents
a) Prothrombinex-VF 25-50 IU/kg
b) FEIBA 25-100 IU/kg
c) rVIIa 90 ug/kg every 2 hours
d) Tranexamic Acid 15-30mg/kg IV+/- infusion for mucosal bleeds
- Consider dialysis
- Neither pro-haemostatic agents or dialysis is likely to improve outcome in patientswith a normal aPTT or aDabigatran level of < 50 ng/mL

Key references

- 2014 ACC/AHA Guideline on Perioperative Cardiovascular Evaluation and Management of Patients Undergoing Noncardiac Surgery. J Am Coll Cardiol 2014;64:e77–137.
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- The Heart Rhythm Society (HRS)/American Society of Anesthesiologists (ASA) Expert Consensus Statement. Heart Rhythm 2011;8:1114 –1152
- P. Slinger (ed.), *Principles and Practice of Anesthesia for Thoracic Surgery*,