Surgical Management of Complicated Pneumonias

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Empyema Thoracis

- Starts as a parapneumonic effusion which is contaminated by adjacent pulmonary infection
- 50-94% parapneumonic fluid collection (Moir C. 1993)
- Mortality rate variable (6-19%)

Incidence of Empyema Thoracis

- 6% empyema thoracis, of all pediatric pneumonia admissions (Goldstraw P. UK 1996)
- 2-8% empyema thoracis (Tan TQ et.al. Pediatrics 2002)

Pleural Fluid Culture

Organism (n=70)	Frequency%
No growth	42.9
Strep. pneumoniae	35.7
Grp A beta hemolytic Strep.	5.7
Staphylococcus areus	5.7
Coagulase (-) Staphylococcus	5.7
Other	4.3

Chen, LE et.al. J Ped Surgery 2002

Empyema Thoracis

1. Exudative phase
2. Fibrinopurulent phase
3. Organizing phase

- Andrews et.al. Am Rev Resp Dis 1962 (adapted by American Thoracic Society)

Empyema Thoracis

1. Exudative phase
   - Non loculating fluid, non-echogenic fibrin deposition with normal pleural fluid glucose and pH
   - Treated with appropriate antibiotics and drainage with thoracentesis or chest tube drainage
2. Fibrinopurulent phase
3. Organizing phase

Empyema Thoracis

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2. Fibrinopurulent phase
   - Beginning loculation, echogenic fibrin deposition, increase PMN's, dropping pH and glucose levels, rising LDH some degree of lung trapping, grossly purulent
   - Treated with larger bore chest tube drainage, with fibrinolysis ? or early VATS/thoracotomy
3. Organizing phase

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3. Organizing phase
   - Thick inelastic, highly echoic fibrin, lung not able to expand, acidic ph, very low glucose, elevated LDH, presence of fibroblasts
   - Thoracotomy, VATS?

Clinical Phases of ET

- Useful in designing treatment regimen especially when it involved early surgical intervention
- Was not a good predictor of outcome
- Dependent on the interpretation of sonogram or CT scan

Empyema Severity Score

Hoff, et.al. J Ped Surg 1989

- Presence of Peel
- Scoliosis
- Gram(-) and anaerobes in culture
- Atypical cultures
- pH < 7.2
- Glucose <40mg/dL

Empyema Severity Score

- Each variable given a score of 1

ESS = 0 mild disease
ESS = 1 moderate disease
ESS = 2 severe disease

- Better predictor for outcome

Empyema Severity Score

- Wong et.al. Ind J Peds 2005

1. Clinical Features
   - Fever > 39^0C
   - > 7 days before initial admission
   - Tachycardia 140/min
   - Tachypnea >40/min
   - Abdominal pain
   - Required volume expansion
   - Inotropic support
   - Ventilatory support

Empyema Severity Score

- Wong et.al Ind J Peds 2005

1. Clinical Features
2. Laboratory
   - WBC < 4 x 10^9/L
   - Platelet count < 100 x 10^9/L
   - PT > 15 seconds
   - BUN > 8 µmol/L
   - Creatinine > 110 mmol/L
   - Pleural pH <7.1
   - Gross pus on pleural aspirate

Empyema Severity Score

- Wong et.al Ind J Peds 2005

1. Clinical Features
2. Laboratory
3. Radiographic Findings
   - Bilateral involvement
   - Empyema thickness > 3 cm on CT scan
   - Multiple loculations
   - Empyema involving > 1/3 of hemithorax
   - Presence of air-fluid levels

Each criteria assigned a value of 1 (20 maximal score)

Empyema Severity Score

- Wong et.al Ind J Peds 2005

1. Clinical Features
2. Laboratory
3. Radiographic Findings

Each criteria assigned a value of 1 (20 maximal score)

Conclusion

A score of 4 or more predicted almost a 5 fold increase likelihood of surgical intervention

Conservative Management

- Drainage should not be withheld!
- Rodriguez C et.al. Asian CV Thorac Ann 2006

Table 1. Age of Patients with Empyema Thoracis

Age	Number	(%)
<= 1	12	39
2 to 10	6	19
11 to 10	13	42

Conservative Management

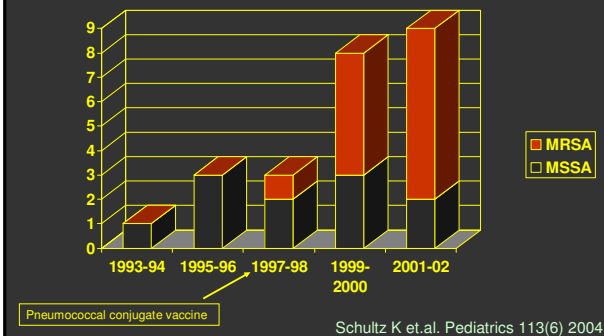
Table 2. Bacteriology Profile

Age	Culture growth	Number
<1	Staphylococcus aureus	3
	Pseudomonas aeruginosa	1
	Brockholderia alvei	1
1	Staphylococcus aureus	2
	Hemophilus influenza	1
	Streptococcus pneumo	1
	Escherichia coli	1
	Brockholderia alvei	1
2 to 10	Staphylococcus aureus	3
	Hemophilus influenza	1
	Enterobacter glomerans	1
	Alkaligenes faecalis	1
11 to 18	Pseudomonas aeruginosa	2
	Streptococcus pneumo	2
	Streptococcus viridans	1
	Staphylococcus aureus	1
	Acinetobacter	1
	Hafnea alvei	1

No growth in 6 patients

•Rodriguez C et.al. Asian CV Thorac Ann 2006

Bacteriology



Schultz K et.al. Pediatrics 113(6) 2004

Conservative Management

Time (days)	No. of Cases	(%)
No re-expansion	24	71
1 to 7	2	6
8 to 14	3	9
15 to 21	1	3
Unknown	4	12

Time for Radiographic Re-expansion

•Rodriguez C et.al. Asian CV Thorac Ann 2006

Conservative Management

	Duration of Drainage		Duration to Conversion To Open Drainage		Length of Hospitalization	
Days	Number	%	Number	%	Number	%
1-7	4	12	6	23	0	0
8-14	5	15	10	38	2	6
15-21	1	3	7	27	4	12
22-28	0	0	1	4	9	27
>= 29	3	9	1	4	17	52
>= 57	1	3	1	4	1	3
>= 85	6	18	-	-	-	-
?	14	41	-	-	-	-

•Rodriguez C et.al. Asian CV Thorac Ann 2006

Conservative Management

Treatment Outcome	Number	(%)
Chest Tube Removed	7	20
Recurrence	2	6
Open Drainage	26	74
Modified Heimlich Valve	10	29
MHV → Tube Removed	1	3
MHV → demise	1	3
Open Tube Drainage	16	46
Open Tube → Tube Removed	4	11
Recurrence	1	3
Demise	2	6

•Rodriguez C et.al. Asian CV Thorac Ann 2006

Conservative Management

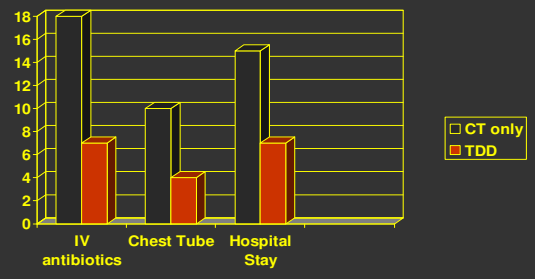
- Conclusions
  - Conservative management associated with considerable hospital stay, length of chest tube placement and mortality (8.8%)*
  - Failure rate is high and early surgery is warranted for complicated empyema

Conservative Management

* Unique population of service patients where some variables are not controlled
  - Isolation
  - Antibiotic therapy
  - Availability of VATS
  - Chest tube care

Thoracotomy vs Conservative

Clinical Durations



Cohen G et.al JTCVS 2003 (n=54)

Fibrinolytic Therapy

- Mode of action (improves drainage of fluid)
  - Lyse fibrinous strands
  - Clears lymphatic pores
- Streptokinase, urokinase, alteplase, rTPA
- 11 clinical trials comparing to surgery, one was RCT
- Variable protocols

Fibrinolysis vs VATS

TABLE 2. BASELINE CHARACTERISTICS OF THE PATIENTS ACCORDING TO STUDY GROUP

Variable	VATS (*n* = 30)	Urokinase (*n* = 30)	p Value
Sex, no.			
Females	14	13	0.79
Males	16	17	
Age, yr			
Median	3.57	3.07	0.355
Interquartile range	2.28–7	2.28–5.38	
Illness days before admission	10 (6–34)	9 (2–37)	0.458
Illness days before intervention	11 (6–37)	9 (5–38)	0.263
Pre-op days after admission	1 (0–3)	1 (0–3)	0.071
WBC × 10⁹/L			
Median	18	15.22	0.223
Interquartile range	10.8–23.3	10.6–20.4	
CRP, mg/L			
Median	153	183	0.744
Interquartile range	96–241	45–292	
Platelets × 10⁹/L			
Median	500	476	0.59
Interquartile range	370–640	352–682	
Hb, g/dL			
Median	10.1	10.05	0.740
Interquartile range	8.7–11.4	8.6–11.2	
Pleural fluid LDH, U/L	*n* = 17	*n* = 24	
Median	10,000	6,953	0.368
Interquartile range	4880–20,000	2,992–16,554	
Pleural fluid albumin, g/L	*n* = 17	*n* = 24	
Median	21	21.5	0.151
Interquartile range	20–29	20–46	
Pleural fluid WBC	*n* = 24	*n* = 23	
+/−	21/3	21/2	0.79
Fever days after intervention	2.5 (0–10)	2.5 (0–25)	0.635
O_2 supplementation	12	12	1
Microbiology (positive blood or fluid culture and/or PCR)			
S. pneumoniae	18	13	0.196
Other organisms	3	6	0.317

Definition of abbreviations: CRP = C-reactive protein; LDH, lactate dehydrogenase; PCR = polymerase chain reaction; VATS = video-assisted thoracoscopic surgery; WBC = white blood cells.

Sonnappa S et.al Am J Respir Crit Care Med 174 2006

Fibrinolysis vs VATS

- Protocol
  - < 1 year old
    - 10,000 U in 10 cc every 12 h for 3 days
  - >1 year old
    - 40,000 U in 40 cc every 12 h for 3 days

Urokinase chosen for availability, cost, and commonly used in pediatric age groups

Fibrinolytic vs VATS

- Intention to treat (crossover)
- Failure defined as persistent fever 4 days after initial fibrinolysis administration
- Treatment failure
  - 5 in FT required VATS
  - 4 in VATS converted to open minithoracotomy
  - Not statistically significant

Fibrinolysis vs VATS

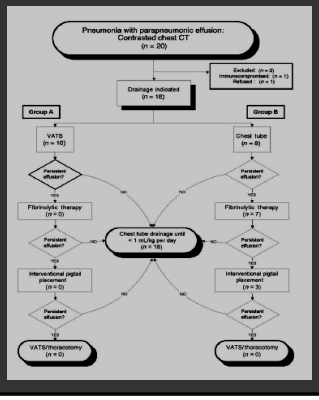
Conclusions

- Marginally significant length of chest tube placement in favor of VATS (p = 0.055)
- No difference in hospital LOS
- Significant difference in total hospital costs in favor of fibrinolysis

Fibrinolysis vs VATS

- VATS was highly skill dependent which would account for the high conversion rate
- Disadvantage is fibrinolytic therapy makes surgery more difficult

VATS vs Thoracostomy



Kurt, B et.al
Pediatrics
118(3) 2006

VATS vs Thoracostomy

Patient Outcomes

Variable	Thoracostomy (*n* = 8)	VATS (*n* = 10)	*P*
Length of stay, d	13.25 ± 7.15	5.80 ± 2.82	.004
Days of tube drainage	9.63 ± 5.45	2.80 ± 0.63	<.001
Fever duration, d	6.25 ± 4.10	3.60 ± 2.95	.146
Oxygen need, d	3.63 ± 5.71	1.60 ± 1.26	.965
Narcotic use, d	7.63 ± 6.32	2.20 ± 1.48	.043
No. of CXRs	16.75 ± 9.90	8.10 ± 2.33	.016
No. of chest CT scans	3.13 ± 1.25	1.0 ± 0.00	<.001
No. of procedures	2.25 ± 1.91	1.0 ± 0.00	.002
Procedure time, min	30.00 ± 6.93	47.44 ± 14.59	.016
Sedation time, min	80.63 ± 28.96	86.20 ± 17.42	.460
Need for fibrinolysis	2.63 ± 2.07	0	.001
Facility charges, $	18 447 (13 931–29 562)*	12 988 (10 799–15 606)*	.016
Physician charges, $	4414 (3718–7896)*	6668 (5634–7291)*	.146
Total charges, $	21 947 (17 895–37 458)*	19 714 (17 325–23 000)*	.315

Data are presented as mean ± SD (unless otherwise specified) with *P* values determined by the Mann-Whitney test.
* Median (25th–75th percentile).

Kurt, B et.al Pediatrics 118(3) 2006

VATS vs Thoracostomy

- Conclusions
  - Early VATS for primary empyema in stage 1 and 2 is superior to tube thoracostomy

(No failure rates for VATS)

Video Assisted Thoracoscopic Surgery

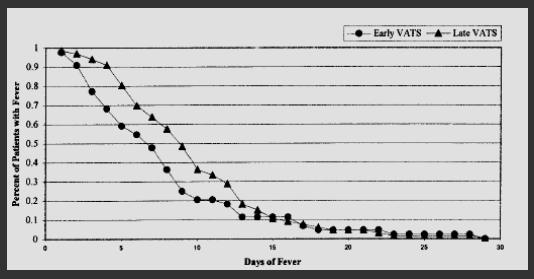
- When to intervene?
- Texas Children's Review (n=230 10 year review)

Schultz K et.al. Pediatrics 113(6) 2004

Early vs Late VATS

- N = 49 early VATS (within 48 hours of admission)
- N = 78 late VATS (> 48 hours from admission)

Early vs Late VATS



Schultz K et.al. Pediatrics 113(6) 2004

Early vs Late VATS

	Early VATS	Late VATS	*P* Value
LOS (all patients)	11.49 ± 6.56	15.18 ± 8.62	.008
Age	5.01 ± 4.23	3.78 ± 3.24	NS
Admission service, %			.04
General pediatrics	51	67	
Pulmonary	26	20	
Surgery	12	1	
Other	10	12	
LOS (Texas Children's Hospital admission only)	9.91 ± 2.95	12.34 ± 2.80	.027

Schultz K et.al. Pediatrics 113(6) 2004

Early vs Late VATS

	Early (n = 46)	Late* (n = 79)
Lung abscess	3	4
Pneumatocele	2	7
Bronchopleural fistula	1	1
Respiratory failure (before or after procedure)	5	6
Blood transfusion	9	18
Air leak >24 h	3	5
Lobectomy	3	3

* There were no significant differences found.

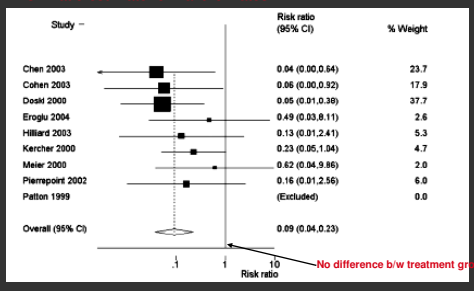
Schultz K et.al. Pediatrics 113(6) 2004

Early vs Late VATS

- Early VATS is safe for complicated empyemas and shows to decrease LOS, and trends towards quicker resolution of fever

Non operative vs Primary operative

Risk Ratio estimate for Failure Rates



Avansino J et.al Pediatrics 115(6) 2005

Non operative vs Primary operative

	Nonoperative Therapy		Primary Operative Therapy (n = 363)*	
	Chest Tube and Antibiotics (n = 3183)	Primary Fibrinolytic Therapy (n = 64)	VATS (n = 176)	Thoracotomy (n = 175)
Age, y (cases/studies)	5 (1691/35)	4.1 (64/3)	5.1 (176/13)	6.7 (99/6)
Mortality rate, % (cases/studies)	3.3 (3250/50)	0 (64/3)	0 (176/13)	0 (166/11)
Failure rate, % (cases/studies)	23.6 (2793/44)	9.4 (64/3)	2.8 (176/13)	3.1 (128/9)
Length of stay, d (cases/studies)	20.0 (1671/33)	10.7 (64/3)	11.2 (150/10)	10.6 (122/8)
Chest tube, total d (cases/studies)	10.6 (1566/28)	4 (14/1)	4 (144/8)	6.2 (22/2)
Antibiotics, d (cases/studies)	21.3 (381/12)	NS	13.2 (56/4)	NS
Complication rate, % (cases/studies)	5.6 (1094/22)	12.5 (64/3)	5.4 (168/11)	5.2 (77/5)

NS indicates not specified.

- *Conclusions*

  Primary operative therapy is associated with a lower in-hospital mortality rate, lower re-intervention rate, LOS, duration of tube drain, and time of antibiotic therapy compared to the non-operative group

Consider Local Multi-Center Trial

- Define failure of medical management
  - Days of antibiotic therapy
  - Clinical/radiographic parameters
- Define Severity Scoring
- Primary outcome measures
  - Hospital stay after final intervention
  - QOL questionnaire at one month after discharge

Thank You