**Supplemental information**

*Contraindications to drainage:*

**Supplemental Table 1: 26 patients with contraindications to drainage had a total of 46 contraindications listed (eight of these patients underwent delayed drainage)**

|  |  |
| --- | --- |
| **Contraindication to Drainage** | **Number of Instances** |
| Non-iatrogenic coagulopathy | 21 |
| Anticoagulation with high reversal risk | 20 |
| Palliative/futile | 2 |
| Unsafe for unspecified reason | 2 |
| Consent refused | 1 |

*Further oxygenation outcomes:*

**Supplemental Table 2: Other oxygenation outcomes**

|  |  |  |
| --- | --- | --- |
|  | **EDG**  **Median (IQR)** | **Controls**  **Median (IQR)** |
| **P:F ratio at 1 hour post-drainage compared to baseline**  ***Increment*** | 221 (162 to 306)  *p=*0.06  +8.9% | N/A |
| **P:F ratio at 48 hours compared to baseline**  ***Increment*** | 265 (219 to 305)  *p*<0.01  +30.5% | 251 (189 to 310)  *p=*0.74  +0.4% |
| **Patients with a reduction in P:F ratio at 24 hours compared to baseline\*** | 3 (3.9%) | 26 (17.4%) |

\*A greater number of patients undergoing expectant management had a significant decrease in P:F ratio at 24 hours compared with the early drainage group (*p*<0.01, RR 3.6 (1.4 to 10.6)).

*Diagnostic Impacts of drainage:*

62 drainage procedures resulted in a complete change of diagnosis. 40 (33.6%) drainages ruled out presumed pleural infection (n=37) and metastatic malignancy (n=3). 22 (18.5%) drainages revealed previously unsuspected conditions: eight pleural infections; six oesophagopleural fistulae; five malignant pleural effusions; two haemothoraces; two chylothoraces and one pancreatopleural fistula.

A further 29 procedures narrowed the differential diagnoses, confirming one of multiple previously suspected causes. 19 cases of pleural infection; two oesophagopleural fistulae; two cases of malignant pleural effusion; two traumatic haemothoraces; one chylothorax and one hepatic hydrothorax were confirmed.

28 (23.5%) non-repetitive drainage procedures had no significant effect on diagnostic accuracy. 15 of these had no fluid specimens sent for routine biochemical nor microbiological analysis, possibly impairing their diagnostic potential.

*Therapeutic impacts of drainage:*

The most important treatment changes for each case included: 31 cases where antibiotics were started, changed or ceased as a result of drainage; 20 drainages resulted in weaning from NIV or extubation; eight drainages prompted and facilitated palliative care; seven drainages changed presumptive diagnosis, facilitating surgical management of non-pleural disease; six avoided planned thoracotomy for empyema (four with intrapleural tPA/DNase); five resulted in optimised treatment for transudative causes; and three resulted in optimised treatment for unrecognised postoperative chylothorax.

*Adverse event rates:*

**Supplemental Table 3: Number of patients in each group that developed at least one serious adverse event**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Early drainage (n=76)** | **Controls**  **(n=150)** | **RR (95% CI)** | ***p* value** |
| **PERSAE** | 8 (10.5%) | 24 (16.0%) | 1.52 (0.74 to 3.20) | 0.32 |
| **Other SAE** | 1 (1.3%) | 11 (6.7%) | 5.57 (0.96 to 33.37) | 0.06 |
| **Total SAE** | 9 (11.8%) | 35 (23.3%) | 1.97 (1.03 to 3.89) | **<0.05** |

SAE, severe adverse events. PERSAE, pleural effusion related severe adverse events. RR, relative risk. CI, confidence interval.

PERSAEs consisted of: 3 failed insertions, (1 requiring CT-guided drain, 2 resulting in pneumothoraces); 1 haemothorax post-thrombolytics for empyema; 1 bronchopleural fistula with subcutaneous emphysema resulting in tube dislodgement; 1 hypotension and hypoxia after rapid fluid drainage requiring new vasopressor infusion and increased PEEP for re-expansion pulmonary oedema; 1 recurrent hydropneumothorax after drain removal; 1 drain blocked resulting in pneumothorax and reinsertion.

One patient (1.3%) suffered a non-PERSAE serious adverse event (pericardial drain resulted in pneumothorax contralateral to pleural drain). A further six patients suffered seven non-serious adverse events (7.9%): 2 drains dislodged after evacuation of fluid, not requiring any intervention or change of management; 4 small pneumothoraces not requiring intervention (ex vacuo related to trapped lung); 1 had pain requiring increased opioid dose.

*Controls:* 24/150 (16.0%) patients suffered 29 PERSAEs. 15 patients suffered worsening respiratory failure requiring either readmission to ICU, medical emergency team activation, non-invasive ventilation, or reintubation together with specific treatment to manage pleural effusion, of whom five died with irreversible respiratory failure as a contributing cause of death; 8 patients had missed pleural infections diagnosed on subsequent drainages; 1 patient had a missed chylothorax; 1 had a missed lymphoma-related effusion. Delayed drainage complications included 2 drain dislodgements requiring reinsertion; one lung parenchymal placement and 1 bronchopleural fistula on delayed drainage of advanced empyema.

11 patients suffered 11 non-PERSAE serious adverse events. Eight patients developed worsening respiratory failure requiring reintubation deemed unrelated to pleural effusion; two patients developed hospital acquired pneumonia resulting in readmission or death; one developed pneumothorax related to pericardiocentesis.

Two further patients had non-serious adverse events: one with increased oxygen requirement and increased pleural effusion that was not drained prior to discharge from hospital; the other persisting pleural effusion and dyspnoea at outpatient follow up 10 weeks after hospital discharge.

*Oxygenation effects in delayed drainage procedures:*

15/27 (55.6%) patients remained in the ICU and had complete P:F ratio data. Mean P:F ratio pre-drainage was 197 (+/- 58.0) and this increased to 269.1 (+/- 65.8, *p*<0.01, 35.1%) at 24 hours and 260.0 (+/- 80.6, *p*=0.05, 32.0%) at 48 hours after drainage. None of these patients had a significant decrease in P:F ratio.

*Details of drainage procedure techniques:*

81/137 (59.1%) used “small bore” (<16Fr) chest tubes, 50/137 (36.5%) “large bore” chest tubes and six were thoracenteses. All small bore tubes and 13 large bore tubes were inserted using a modified Seldinger technique. 30/137 (21.9%) of procedures were performed outside the ICU. Seven procedures were performed in the operating theatre and three in the radiology department whilst the patient remained under the care of the ICU and 20 on the ward after ICU discharge.

*Successful drainage procedures:*

103 patients underwent drainage procedures at some time point. Beneficial determinants of successful drainage included improved P:F ratio at 24 hours; ability to wean from NIV and/or extubate; change in clinicians diagnosis and change in clinicians treatment as a result of drainage. 90/103 (87.4%) of patients derived at least one benefit of drainage(s) without any PERSAE’s and 79/103 (76.7%) had at least one benefit without any adverse event (complete success).