Supplementary Table

Promising Effects of Digital Chest Tube Drainage System for Pulmonary Resection: A Systematic Review and Network Meta-Analysis

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Contents

Supplementary Table S1. PRISMA for Network Meta-Analyses

Section/ Topic	Item	Checklist Item	Reported on Page #
TITLE			
Title	1	Identify the report as a systematic review *incorporating a network meta-analysis (or related form of meta-analysis).*	Title page
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: **Background:** main objectives **Methods:** data sources; study eligibility criteria, participants, and interventions; study appraisal; and *synthesis methods, such as network meta-analysis.* **Results:** number of studies and participants identified; summary estimates with corresponding confidence/credible intervals; *treatment rankings may also be discussed. Authors may choose to summarize pairwise comparisons against a chosen treatment included in their analyses for brevity.* **Discussion/Conclusions:** limitations; conclusions and implications of findings. **Other:** primary source of funding; systematic review registration number with registry name.	1
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known*, including mention of why a network meta-analysis has been conducted.*	2, 3
Objectives	4	Provide an explicit statement of questions being addressed, with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	3
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists and if and where it can be accessed (e.g., Web address); and, if available, provide registration information, including registration number.	4
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale. *Clearly describe eligible treatments included in the treatment network, and note whether any have been clustered or merged into the same node (with justification).*	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4,5

Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	4
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5, 6
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	6,7
Geometry of the network	**S1**	Describe methods used to explore the geometry of the treatment network under study and potential biases related to it. This should include how the evidence base has been graphically summarized for presentation, and what characteristics were compiled and used to describe the evidence base to readers.	7,8
Risk of bias within individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	9
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means). *Also describe the use of additional summary measures assessed, such as treatment rankings and surface under the cumulative ranking curve (SUCRA) values, as well as modified approaches used to present summary findings from meta-analyses.*	7,8
Planned methods of analysis	14	Describe the methods of handling data and combining results of studies for each network meta-analysis. This should include, but not be limited to: *Handling of multi-arm trials;* *Selection of variance structure;* *Selection of prior distributions in Bayesian analyses; and Assessment of model fit.*	6 - 9
Assessment of Inconsistency	**S2**	Describe the statistical methods used to evaluate the agreement of direct and indirect evidence in the treatment network(s) studied. Describe efforts taken to address its presence when found.	8,9
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	9
Additional analyses	16	Describe methods of additional analyses if done, indicating which were pre-specified. This may include, but not be limited to, the following: Sensitivity or subgroup analyses; Meta-regression analyses; *Alternative formulations of the treatment network; and Use of alternative prior distributions for Bayesian analyses (if applicable).*	9

RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	10, Figure 1
Presentation of network structure	**S3**	Provide a network graph of the included studies to enable visualization of the geometry of the treatment network.	Figure 2
Summary of network geometry	**S4**	Provide a brief overview of characteristics of the treatment network. This may include commentary on the abundance of trials and randomized patients for the different interventions and pairwise comparisons in the network, gaps of evidence in the treatment network, and potential biases reflected by the network structure.	eFigure 3
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	10,11, Table1, eTable 3
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment.	13, 14, eTable 6
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: 1) simple summary data for each intervention group, and 2) effect estimates and confidence intervals. *Modified approaches may be needed to deal with information from larger networks.*	11-13
Synthesis of results	21	Present results of each meta-analysis done, including confidence/credible intervals. *In larger networks, authors may focus on comparisons versus a particular comparator (e.g. placebo or standard care), with full findings presented in an appendix. League tables and forest plots may be considered to summarize pairwise comparisons.* If additional summary measures were explored (such as treatment rankings), these should also be presented.	11-13
Exploration for inconsistency	**S5**	Describe results from investigations of inconsistency. This may include such information as measures of model fit to compare consistency and inconsistency models, *P* values from statistical tests, or summary of inconsistency estimates from different parts of the treatment network.	12, 13
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies for the evidence base being studied.	13, 14
Results of additional analyses	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression analyses*, alternative network geometries studied, alternative choice of prior distributions for Bayesian analyses,* and so forth).	13, 14
DISCUSSION			
Summary of evidence	24	Summarize the main findings, including the strength of evidence for each main outcome; consider their relevance	15

		to key groups (e.g., healthcare providers, users, and policy-makers).	
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review level (e.g., incomplete retrieval of identified research, reporting bias). *Comment on the validity of the assumptions, such as transitivity and consistency. Comment on any concerns regarding network geometry (e.g., avoidance of certain comparisons).*	18, 19
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	20
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review. This should also include information regarding whether funding has been received from manufacturers of treatments in the network and/or whether some of the authors are content experts with professional conflicts of interest that could affect use of treatments in the network.	21

PICOS = population, intervention, comparators, outcomes, study design.
* Text in italics indicateS wording specific to reporting of network meta-analyses that has been added to guidance from the PRISMA statement.

Supplementary Table S2. Search Strategy

Data base	Search Strategy
Pubmed	((("pulmonary surgical procedures"[MeSH Terms] OR ("pulmonary"[All Fields] AND "surgical"[All Fields] AND "procedures"[All Fields]) OR "pulmonary surgical procedures"[All Fields] OR ("lung"[All Fields] AND "surgery"[All Fields]) OR "lung surgery"[All Fields] OR (("lung"[MeSH Terms] OR "lung"[All Fields] OR "pulmonary"[All Fields]) AND ("resect"[All Fields] OR "resectability"[All Fields] OR "resectable"[All Fields] OR "resectates"[All Fields] OR "resected"[All Fields] OR "resecting"[All Fields] OR "resection"[All Fields] OR "resectional"[All Fields] OR "resectioned"[All Fields] OR "resectioning"[All Fields] OR "resections"[All Fields] OR "resective"[All Fields] OR "resects"[All Fields]))) AND ("chested"[All Fields] OR "thorax"[MeSH Terms] OR "thorax"[All Fields] OR "chest"[All Fields] OR "chests"[All Fields] OR ("lung"[MeSH Terms] OR "lung"[All Fields] OR "pulmonary"[All Fields]) OR ("pleura"[MeSH Terms] OR "pleura"[All Fields] OR "pleural"[All Fields]) OR ("digital"[All Fields] OR "digitalisation"[All Fields] OR "digitalised"[All Fields] OR "digitalization"[All Fields] OR "digitalize"[All Fields] OR "digitalized"[All Fields] OR "digitalizer"[All Fields] OR "digitalizing"[All Fields] OR "digitally"[All Fields] OR "digitals"[All Fields] OR "digitization"[All Fields] OR "digitizations"[All Fields] OR "digitize"[All Fields] OR "digitized"[All Fields] OR "digitizer"[All Fields] OR "digitizers"[All Fields] OR "digitizes"[All Fields] OR "digitizing"[All Fields]))) AND

	("drainage"[MeSH Terms] OR "drainage"[All Fields] OR "drainaged"[All Fields] OR "drainages"[All Fields] OR ("suction"[MeSH Terms] OR "suction"[All Fields] OR "suctioning"[All Fields] OR "suctions"[All Fields] OR "suctioned"[All Fields] OR "suctionings"[All Fields]) OR (("air"[MeSH Terms] OR "air"[All Fields]) AND "leak"[All Fields]))) AND (clinicaltrial[Filter] OR randomizedcontrolledtrial[Filter])
Embase, MEDLINE	('lung surgery'/exp OR 'lung surgery' OR (('lung'/exp OR lung) AND ('surgery'/exp OR surgery)) OR 'pulmonary resection'/exp OR 'pulmonary resection' OR (pulmonary AND ('resection'/exp OR resection))) AND ('chest'/exp OR chest OR pulmonary OR pleural OR digital) AND ('drainage'/exp OR drainage OR 'suction'/exp OR suction OR 'air leak'/exp OR 'air leak' OR (('air'/exp OR air) AND ('leak'/exp OR leak))) AND ([controlled clinical trial]/lim OR [randomized controlled trial]/lim)
Cochrane Library	Trials matching "#1 - ((lung surgery OR pulmonary resection)):ti,ab,kw AND ((chest OR pulmonary OR pleural or digital)):ti,ab,kw AND ((drainage OR suction OR air leak)):ti,ab,kw (Word variations have been searched)" in Trials (Word variations have been searched)

Supplementary Table S3. Characteristics of included studies.

Table. Characteristics of included studies

Study	Study Design	Nationality	Scenario	Intervention 1	Intervention 2
Marshall 2002	RCT	The US	NR	Traditional suction (-20 cm H_2O suction)	Water seal
Ayed 2003	RCT	Kuwait	Primary spontaneous pneumothorax :100%	Traditional suction (-20 cm H_2O suction)	Water seal
Brunelli 2004	RCT	Italy	Lung cancer: 100%	Traditional suction (-20 cm H_2O suction)	Water seal
Alphonsoa 2005	RCT	The UK	NR	Traditional wall-mounted suction (2 kPa.)	Water seal
Brunelli 2005	RCT	Italy	Lung cancer: 100%	Traditional suction (-10 cm H_2O suction)	Water seal
Kakhki 2006	RCT	Iran	NR	Traditional suction (-10/-16 to -18 cm H_2O suction)	Water seal
Cerfolio 2008	RCT	The US	Malignant pulmonary tumor: 85% Benign pulmonary tumor: 15%	Digital drainage system: Digivent® (Millicore, Sweden)	Water Seal: Sahara S-11000® (Teleflex, Research Triangle Plus, NC, US)
Prokakis 2008	RCT	Greece	Lung cancer: 100%	Traditional suction (-15 to -20 cm H_2O suction)	Water seal
Brunelli 2010	RCT	Italy	Lung cancer: 100%	Digital drainage system: DigiventTM®, Millicore AB, Danderyd, Sweden	Traditional suction: Pleur Evac A®-6002-08, Teleflex Inc., Research Triangle Park, NC, USA) Alternate suction (-15 cm H_2O during night and no suction during the day)

Filosso 2010	RCT	Italy	Lung cancer: 100%	Digital drainage system: Drentech Simple PLUS® P.A.L.M (REDAX,Mirandola, Italy)	Traditional wall suction(-20 cm H_2O)
Bertolaccini 2011	RCT	Italy	NR	Digital drainage system: Drentech Palm® (Redax S.r.l., Mirandola (MO),Italy	Water seal
Marjański 2013	RCT	Poland	Lung cancer: 100%	Digital drainage system: Thopaz®, Medela, Switzerland	Traditional central wall suction(-15 cm H_2O)
Brunellia 2013	RCT	Italy	Lung cancer: 100%	Digital drainage system: Thopaz®, Medela, Switzerland) (regulated individualized suction mode; -11 to -20 cm H_2O)	Water seal (regulated seal mode) (−2 cm H_2O) Thopaz® (Medela, Switzerland)
Leo 2013	RCT	Italy	NR	Digital drainage system: Thopaz®, Medela, Switzerland(-15 cm H_2O)	Water seal: Drentech®; Redax, Mirandola, Italy
Pompili 2014	RCT	Multicenter trial (Italy, the US, the UK, and China)	NR	Digital drainage system: Thopaz®, Medela, Switzerland	Traditional suction (-20 cm H_2O suction until the morning of POD 1 and water seal thereafter)
Gilbert 2015	RCT	Canada	Malignant pulmonary tumor: 92.4% Benign pulmonary tumor: 7.6%	Digital drainage system: Thopaz®, Medela, Switzerland	Water seal: Pleur Evac A®-6002-08 (Teleflex Inc., Research Triangle Park, NC, US)
Lijkendijk 2015	RCT	Denmark	NR	Digital drainage system: Thopaz® (Medela, Switzerland) (-15 cm H_2O)	Water-seal: Thora-Seal® (Covidien, Mansfield, MA, USA)
Gocyk 2016	RCT	Poland	Lung cancer: 53.94% Metastatic lung tumor: 9.06% Benign lung tumor: 14.57% Other: 22.44%	Traditional suction: Thora-Seal III® (TYCO Healthcare Ltd. Gosport, UK) (continuous -20 cmH_2O suction)	Water seal: Thora-Seal III® (TYCO Healthcare Ltd. Gosport, UK) (-20 cm H_2O suction until the morning of POD 1 and water seal thereafter)

Chiappetta 2017	RCT	Italy	Malignant or benign pulmonary tumor	Digital drainage system: Drentech Simple Plus PALM, Redax; Mirandola, Modena, Italy;	Water-seal
Plourde 2018	RCT	Canada	Lung tumor	Digital drainage system:ATMOS® (MedizinTechnik, Sulz, Germany)	Traditional suction: Atrium® (Oasis, AtriumMedical Corp, Hudson, NH, US) (- 20 cm H_2O)
Takamochi 2018	RCT	Japan	Lung cancer: 87.29% Metastatic lung tumor: 7.02% Benign lung tumor: 3.68% Other: 2.34%	Digital drainage system: Thopaz® (Medela Healthcare, Baar, Switzerland)	Traditional suction: Mera Sucuum MS-008EX® chest drainage system (Senko Medical, Tokyo, Japan), - 10 cm H_20

NR, not recorded; **POD**, postoperative day; **RCT**, randomized control trial; **Scenario**: the indications of pulmonary resection; **UK**, United Kingdom; **US**, United States.

Supplementary Table S4. Results of head-to-head comparison of network meta-analysis

Length of hospital stay: Head-to-head comparison

Outcome: Length of hospital stay (Measure: mean difference)		
Digital	-0.57 (-1.55 to 0.41)	-1.19 (-2.14 to -0.25)
-0.35 (-1.17 to 0.47)	Non-suction	-1.33 (-2.45 to -0.21)
-1.40 (-2.20 to -0.60)	-1.05 (-1.91 to -0.18)	Suction
Network Meta-analysis Estimate	Comparator	Direct Estimate

Teble S4.1: Outcomes for hospital stay in network meta-analysis: head-to-head comparisons
Data are presented as the mean difference with 95% CI in the column-defining treatment compared with the row-defining treatment. Comparisons should be read from left to right.
Digital, Digital chest tube drainage system; **Suction**, Suction chest tube drainage system; **Non-suction**, Non-suction chest tube drainage system; **CI**, Confident interval

Chest tube placement duration: Head-to-head comparison

Outcome: Tube placement duration (Measure: mean difference)		
Digital	-0.39 (-1.20 to 0.41)	-0.52 (-1.30 to 0.25)
-0.22 (-0.88 to 0.43)	Non-suction	-0.62 (-1.43 to 0.18)
-0.68 (-1.32 to -0.04)	-0.45 (-1.11 to 0.20)	Suction
Network Meta-analysis Estimate	Comparator	Direct Estimate

Table S4.2: Outcomes for tube replacement duration in network meta-analysis: head-to-head comparisons
Data are presented as the mean difference with 95% CI in the column-defining treatment compared with the row-defining treatment. Comparisons should be read from left to right.
Digital, Digital chest tube drainage system; **Suction**, Suction chest tube drainage system; **Non-suction**, Non-suction chest tube drainage system; **CI**, Confident interval

Prolonged air leak: Head-to-head comparison

Outcome: Prolonged air leak (Measure: odds ratio)		
Digital	0.75 (0.36 to 1.58)	0.82 (0.36 to 1.84)
0.76 (0.42 to 1.39)	Suction	1.04 (0.57 to 1.91)
0.80 (0.43 to 1.49)	1.05 (0.62 to 1.79)	Non-suction
Network Meta-analysis Estimate	Comparator	Direct Estimate

Table S4.3: Outcomes for prolonged air leak in network meta-analysis: head-to-head comparisons

Data are presented as the odds ratio with 95% CI in the column-defining treatment compared with the row-defining treatment. Comparisons should be read from left to right.

Digital, Digital chest tube drainage system; **Suction**, Suction chest tube drainage system; **Non-suction**, Non-suction chest tube drainage system; **CI**, Confident interval

Supplementary Table S5. Estimation of inconsistency

p-value: The p-value is set as 0.05. If the p-value is more than 0.05, the null hypothesis cannot be rejected and the consistency assumption could be accepted. Thus, if the p-value is less than 0.05, which means statistically significant that inconsistency exists.

Table S5.1 Estimation of inconsistency in outcome for length of hospital stay

Design-by-treatment interaction model

Q statistics to assess homogeneity / consistency

	Q	df	p-value
Total	102.65	13	< 0.0001
Within designs	98.73	12	< 0.0001
Between designs	3.92	1	0.0477

Design-specific decomposition of within-designs Q statistic

Design	Q	df	p-value
Digital:Traditional	29.61	4	< 0.0001
Digital:Water Seal	4.27	4	0.3709
Traditional:Water Seal	64.86	4	< 0.0001

Between-designs Q statistic after detaching of single designs

Detached design	Q	df	p-value
Digital:Traditional	0.00	0	--
Digital:Water Seal	0.00	0	--
Traditional:Water Seal	0.00	0	--

Q statistic to assess consistency under the assumption of a full design-by-treatment interaction random effects model

	Q	df	p-value	tau.within	tau^2.within
Between designs	0.55	1	0.4574	1.0734	1.1522

Node-splitting model

Back-calculation method to split direct and indirect evidence

```
Fixed effects model:

             comparison k prop     nma  direct  indir.    Diff     z p-value
    Digital:Traditional 5 0.83 -1.3586 -1.2522 -1.8696  0.6174  1.98  0.0477
     Digital:Water-Seal 5 0.93 -0.5405 -0.5858  0.0316 -0.6174 -1.98  0.0477
 Traditional:Water-Seal 5 0.25  0.8181  1.2838  0.6664  0.6174  1.98  0.0477

Random effects model:

             comparison k prop     nma  direct  indir.    Diff     z p-value
    Digital:Traditional 5 0.71 -1.3980 -1.1942 -1.9009  0.7067  0.78  0.4326
     Digital:Water-Seal 5 0.69 -0.3493 -0.5678  0.1389 -0.7067 -0.78  0.4326
 Traditional:Water-Seal 5 0.60  1.0488  1.3331  0.6264  0.7067  0.78  0.4326

Legend:
 comparison - Treatment comparison
 k          - Number of studies providing direct evidence
 prop       - Direct evidence proportion
 nma        - Estimated treatment effect (MD) in network meta-analysis
 direct     - Estimated treatment effect (MD) derived from direct evidence
 indir.     - Estimated treatment effect (MD) derived from indirect evidence
 Diff       - Difference between direct and indirect treatment estimates
 z          - z-value of test for disagreement (direct versus indirect)
 p-value    - p-value of test for disagreement (direct versus indirect)
```

Table S5.2 Estimation of inconsistency in outcome for chest tube placement duration

Design-by-treatment interaction model

Q statistics to assess homogeneity / consistency

	Q	df	p-value
Total	101.03	14	< 0.0001
Within designs	59.49	13	< 0.0001
Between designs	41.54	1	< 0.0001

Design-specific decomposition of within-designs Q statistic

Design	Q	df	p-value
Digital:Traditional	14.75	4	0.0052
Digital:Water Seal	1.66	4	0.7987
Traditional:Water Seal	43.09	5	< 0.0001

Between-designs Q statistic after detaching of single designs

Detached design	Q	df	p-value
Digital:Traditional	0.00	0	--
Digital:Water Seal	0.00	0	--
Traditional:Water Seal	0.00	0	--

Q statistic to assess consistency under the assumption of a full design-by-treatment interaction random effects model

	Q	df	p-value	tau.within	tau^2.within
Between designs	0.98	1	0.3202	0.6436	0.4142

Node-splitting model

Back-calculation method to split direct and indirect evidence

Fixed effects model:

comparison	k	prop	nma	direct	indir.	Diff	z	p-value
Digital:Traditional	5	0.78	-1.0396	-0.7291	-2.1186	1.3895	6.45	< 0.0001
Digital:Water-Seal	5	0.69	-0.0595	-0.4959	0.8936	-1.3895	-6.45	< 0.0001
Traditional:Water-Seal	6	0.54	0.9801	1.6227	0.2332	1.3895	6.45	< 0.0001

Random effects model:

comparison	k	prop	nma	direct	indir.	Diff	z	p-value
Digital:Traditional	5	0.68	-0.6797	-0.5237	-1.0167	0.4930	0.70	0.4824
Digital:Water-Seal	5	0.66	-0.2248	-0.3938	0.0992	-0.4930	-0.70	0.4824
Traditional:Water-Seal	6	0.66	0.4549	0.6229	0.1299	0.4930	0.70	0.4824

Legend:

comparison	Treatment comparison
k	Number of studies providing direct evidence
prop	Direct evidence proportion
nma	Estimated treatment effect (MD) in network meta-analysis
direct	Estimated treatment effect (MD) derived from direct evidence
indir.	Estimated treatment effect (MD) derived from indirect evidence
Diff	Difference between direct and indirect treatment estimates
z	z-value of test for disagreement (direct versus indirect)
p-value	p-value of test for disagreement (direct versus indirect)

Table S5.3 Estimation of inconsistency in outcome for prolonged air leak

Design-by-treatment interaction model

Q statistics to assess homogeneity / consistency

	Q	df	p-value
Total	20.31	12	0.0614
Within designs	20.16	11	0.0432
Between designs	0.17	1	0.6946

Design-specific decomposition of within-designs Q statistic

Design	Q	df	p-value
Digital:Traditional	6.78	3	0.0791
Digital:Water Seal	0.62	2	0.7343
Traditional:Water Seal	12.76	6	0.0470

Between-designs Q statistic after detaching of single designs

Detached design	Q	df	p-value
Digital:Traditional	0.00	0	--
Digital:Water Seal	0.00	0	--
Traditional:Water Seal	0.00	0	--

Q statistic to assess consistency under the assumption of a full design-by-treatment interaction random effects model

	Q	df	p-value	tau.within	tau^2.within
Between designs	0.00	1	0.9788	0.5526	0.3053

Node-splitting model

Back-calculation method to split direct and indirect evidence

```
Fixed effects model:

             comparison k prop    nma direct indir.    RoR     z p-value
    Digital:Traditional 4 0.63 0.6885 0.6475 0.7643 0.8473 -0.39  0.6946
     Digital:Water-Seal 3 0.66 0.7204 0.7626 0.6461 1.1802  0.39  0.6946
 Traditional:Water-Seal 7 0.71 1.0464 0.9978 1.1776 0.8473 -0.39  0.6946

Random effects model:

             comparison k prop    nma direct indir.    RoR     z p-value
    Digital:Traditional 4 0.65 0.7634 0.7496 0.7891 0.9499 -0.08  0.9362
     Digital:Water-Seal 3 0.59 0.8017 0.8189 0.7779 1.0527  0.08  0.9362
 Traditional:Water-Seal 7 0.77 1.0502 1.0377 1.0924 0.9499 -0.08  0.9362

Legend:
 comparison - Treatment comparison
 k          - Number of studies providing direct evidence
 prop       - Direct evidence proportion
 nma        - Estimated treatment effect (OR) in network meta-analysis
 direct     - Estimated treatment effect (OR) derived from direct evidence
 indir.     - Estimated treatment effect (OR) derived from indirect evidence
 RoR        - Ratio of Ratios (direct versus indirect)
 z          - z-value of test for disagreement (direct versus indirect)
 p-value    - p-value of test for disagreement (direct versus indirect)
```

Supplementary Table S6. Risk of bias table of included studies

Table. Risk of bias in included studies

First author, year	Random Sequence generation (Selection bias)	Allocation Concealment (Selection bias)	Blinding of participants and personnel (Performance bias)	Blinding of outcome assessment (Detection bias)	Incomplete outcome data (Attrition bias)	Selective reporting (Reporting bias)	Other bias
Marshall, 2002	High	High	High	High	Low	Unclear	Low
Ayed, 2003	Unclear	Unclear	High	High	Low	Low	Low
Brunelli, 2004	Unclear	Unclear	High	High	Low	Low	Low
Brunelli, 2005	Low	High	High	High	Low	Low	Low
Alphonso,2005	Low	Unclear	High	High	Unclear	Unclear	Low
Kakhki, 2006	High	Unclear	High	High	Low	Low	Unclear
Cerfolio, 2008	Low	Unclear	High	High	Low	Low	Low
Prokakis, 2008	Low	Unclear	High	High	Low	Low	Low
Brunelli, 2010	Unclear	Unclear	High	High	Low	Low	Low
Filosso, 2010	Unclear	High	High	High	Low	Low	Low
Bertolaccini, 2011	Low	Unclear	High	High	Low	Low	Low
Marjański, 2013	Low	Unclear	High	High	Low	Low	Low
Brunelli, 2013	Low	Unclear	High	High	Low	Low	Low
Leo, 2013	High	Unclear	High	High	Low	Low	Low
Pompili, 2014	Low	Unclear	High	Unclear	Low	Low	Low
Gilbert, 2015	Low	Unclear	High	High	Low	Low	Low
Lijkendijk, 2015	Low	Unclear	High	High	Low	Low	Low
Gocyk, 2016	Low	Unclear	High	High	Low	Low	Low
Chiappetta, 2017	Unclear	Unclear	High	High	Low	Low	Low
Plourde, 2018	Low	High	High	High	Low	Low	High
Takamochi, 2018	Unclear	Unclear	High	High	Low	Low	Low

Supplementary Table S7. Sensitivity analyses

p-value: The p-value is set as 0.05. If the p-value is more than 0.05, the null hypothesis cannot be rejected and the consistency assumption could be accepted. Thus, if the p-value is less than 0.05, which means statistically significant that inconsistency exists.

Table S7.1 Sensitivity analyses regarding the estimation of inconsistency in outcome for length of hospital stay

Design-by-treatment interaction model

Q statistics to assess homogeneity / consistency

	Q	df	p-value
Total	10.51	9	0.3111
Within designs	7.08	8	0.5282
Between designs	3.43	1	0.0641

Design-specific decomposition of within-designs Q statistic

Design	Q	df	p-value
Digital:Traditional	4.27	4	0.3708
Digital:Water Seal	2.14	2	0.3432
Traditional:Water Seal	0.67	2	0.7152

Between-designs Q statistic after detaching of single designs

Detached design	Q	df	p-value
Digital:Traditional	0.00	0	--
Digital:Water Seal	0.00	0	--
Traditional:Water Seal	0.00	0	--

Q statistic to assess consistency under the assumption of a full design-by-treatment interaction random effects model

	Q	df	p-value	tau.within	tau^2.within
Between designs	3.43	1	0.0641	0	0

Node-splitting model

Back-calculation method to split direct and indirect evidence

```
Fixed effects model:

          comparison k prop     nma  direct  indir.    Diff     z p-value
 Digital:Non-suction 5 0.94 -0.5484 -0.5858  0.0686 -0.6543 -1.85  0.0641
     Digital:Suction 3 0.82 -1.0660 -0.9465 -1.6008  0.6543  1.85  0.0641
 Non-suction:Suction 3 0.24 -0.5176 -1.0151 -0.3607 -0.6543 -1.85  0.0641

Random effects model:

          comparison k prop     nma  direct  indir.    Diff     z p-value
 Digital:Non-suction 5 0.88 -0.4862 -0.5660  0.0855 -0.6515 -1.58  0.1132
     Digital:Suction 3 0.78 -1.0612 -0.9169 -1.5684  0.6515  1.58  0.1132
 Non-suction:Suction 3 0.34 -0.5750 -1.0024 -0.3509 -0.6515 -1.58  0.1132

Legend:
 comparison - Treatment comparison
 k          - Number of studies providing direct evidence
 prop       - Direct evidence proportion
 nma        - Estimated treatment effect (MD) in network meta-analysis
 direct     - Estimated treatment effect (MD) derived from direct evidence
 indir.     - Estimated treatment effect (MD) derived from indirect evidence
 Diff       - Difference between direct and indirect treatment estimates
 z          - z-value of test for disagreement (direct versus indirect)
 p-value    - p-value of test for disagreement (direct versus indirect)
```

Table S7.2 Sensitivity analyses regarding the estimation of inconsistency in outcome for chest tube placement duration

Design-by-treatment interaction model

Q statistics to assess homogeneity / consistency

	Q	df	p-value
Total	7.81	10	0.6478
Within designs	6.55	9	0.6840
Between designs	1.26	1	0.2622

Design-specific decomposition of within-designs Q statistic

Design	Q	df	p-value
Digital:Traditional	1.66	4	0.7987
Digital:Water Seal	0.74	2	0.6904
Traditional:Water Seal	4.15	3	0.2456

Between-designs Q statistic after detaching of single designs

Detached design	Q	df	p-value
Digital:Traditional	0.00	0	--
Digital:Water Seal	0.00	0	--
Traditional:Water Seal	0.00	0	--

Q statistic to assess consistency under the assumption of a full design-by-treatment interaction random effects model

	Q	df	p-value	tau.within	tau^2.within
Between designs	1.26	1	0.2622	0	0

Node-splitting model

Back-calculation method to split direct and indirect evidence

```
Fixed effects model:

          comparison k prop     nma  direct  indir.    Diff     z p-value
 Digital:Non-suction 5 0.86 -0.4448 -0.4959 -0.1369 -0.3590 -1.12  0.2622
     Digital:Suction 3 0.85 -1.0324 -0.9790 -1.3381  0.3590  1.12  0.2622
 Non-suction:Suction 4 0.29 -0.5876 -0.8422 -0.4832 -0.3590 -1.12  0.2622

Random effects model:

          comparison k prop     nma  direct  indir.    Diff     z p-value
 Digital:Non-suction 5 0.86 -0.4448 -0.4959 -0.1369 -0.3590 -1.12  0.2622
     Digital:Suction 3 0.85 -1.0324 -0.9790 -1.3381  0.3590  1.12  0.2622
 Non-suction:Suction 4 0.29 -0.5876 -0.8422 -0.4832 -0.3590 -1.12  0.2622

Legend:
 comparison - Treatment comparison
 k          - Number of studies providing direct evidence
 prop       - Direct evidence proportion
 nma        - Estimated treatment effect (MD) in network meta-analysis
 direct     - Estimated treatment effect (MD) derived from direct evidence
 indir.     - Estimated treatment effect (MD) derived from indirect evidence
 Diff       - Difference between direct and indirect treatment estimates
 z          - z-value of test for disagreement (direct versus indirect)
 p-value    - p-value of test for disagreement (direct versus indirect)
```

Table S7.3 Sensitivity analyses regarding the estimation of inconsistency in outcome for prolonged air leak

Design-by-treatment interaction model

Q statistics to assess homogeneity / consistency

	Q	df	p-value
Total	15.57	11	0.1577
Within designs	15.57	10	0.1126
Between designs	0.00	1	0.9529

Design-specific decomposition of within-designs Q statistic

Design	Q	df	p-value
Digital:Traditional	0.62	2	0.7343
Digital:Water Seal	6.78	3	0.0791
Traditional:Water Seal	8.17	5	0.1471

Between-designs Q statistic after detaching of single designs

Detached design	Q	df	p-value
Digital:Traditional	0.00	0	--
Digital:Water Seal	0.00	0	--
Traditional:Water Seal	0.00	0	--

Q statistic to assess consistency under the assumption of a full design-by-treatment interaction random effects model

	Q	df	p-value	tau.within	tau^2.within
Between designs	0.05	1	0.8239	0.4444	0.1974

Node-splitting model

Back-calculation method to split direct and indirect evidence

```
Fixed effects model:

          comparison k prop    nma direct indir.    RoR     z p-value
 Digital:Non-suction 3 0.67 0.7562 0.7626 0.7436 1.0255  0.06  0.9529
     Digital:Suction 4 0.64 0.6535 0.6475 0.6641 0.9751 -0.06  0.9529
 Non-suction:Suction 6 0.70 0.8642 0.8708 0.8492 1.0255  0.06  0.9529

Random effects model:

          comparison k prop    nma direct indir.    RoR     z p-value
 Digital:Non-suction 3 0.61 0.8332 0.8036 0.8813 0.9118 -0.16  0.8724
     Digital:Suction 4 0.66 0.6938 0.7162 0.6531 1.0967  0.16  0.8724
 Non-suction:Suction 6 0.74 0.8327 0.8127 0.8912 0.9118 -0.16  0.8724

Legend:
 comparison - Treatment comparison
 k          - Number of studies providing direct evidence
 prop       - Direct evidence proportion
 nma        - Estimated treatment effect (OR) in network meta-analysis
 direct     - Estimated treatment effect (OR) derived from direct evidence
 indir.     - Estimated treatment effect (OR) derived from indirect evidence
 RoR        - Ratio of Ratios (direct versus indirect)
 z          - z-value of test for disagreement (direct versus indirect)
 p-value    - p-value of test for disagreement (direct versus indirect)
```

Supplementary Table S8. Reference list of included studies.

Article	Reason
Graham,1992[1]	No operation(Trauma, thoracotomy)
Waldhausen, 2002[2]	No lung resection in all patients(children, multiple kind of operation , suction and waterseal(prospective, randomize))
Vuorisalo 2005[3]	Only Comparing device(suction and valve drainage bag(prospective, randomize))
Varela 2008[4]	Limited data without available result(indication to remove chest tubes, no detail data(prospective, randomize))
Lijkendijk, 2014[5]	Limited data without available result(Only abstract)
Waele, 2014[6]	Limited data without available result(Only abstract)
Mier,2016[7]	No operation
Barozzi, 2018[8]	Limited data without available result(Thopaz + self-contained drainage system vs wall suction)
Cui 2019[9]	Only Comparing device(chest tube and suction ball (prospective, randomize))
Marulli, 2019[10]	Limited data without available result(No available result)
Ruigrok, 2020[11]	No lung resection in all patients(spontaneous pneumothorax, no lung resection (prospective, randomize))

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5. Lijkendijk M, Licht PB, Neckelmann K. Digital versus analogue chest tube drainage following lobectomy: A randomised trial. *Interactive Cardiovascular and Thoracic Surgery.* 2014;19:S13.
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Supplementary Table S9. Reference list of included studies.

Reference list of included studies

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15. Pompili C, Detterbeck F, Papagiannopoulos K, et al. Multicenter international randomized comparison of objective and subjective outcomes between electronic and traditional chest drainage systems. Ann Thorac Surg 2014;98(2):490-6; discussion 96-7 doi:10.1016/j.athoracsur.2014.03.043
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Supplementary Figure

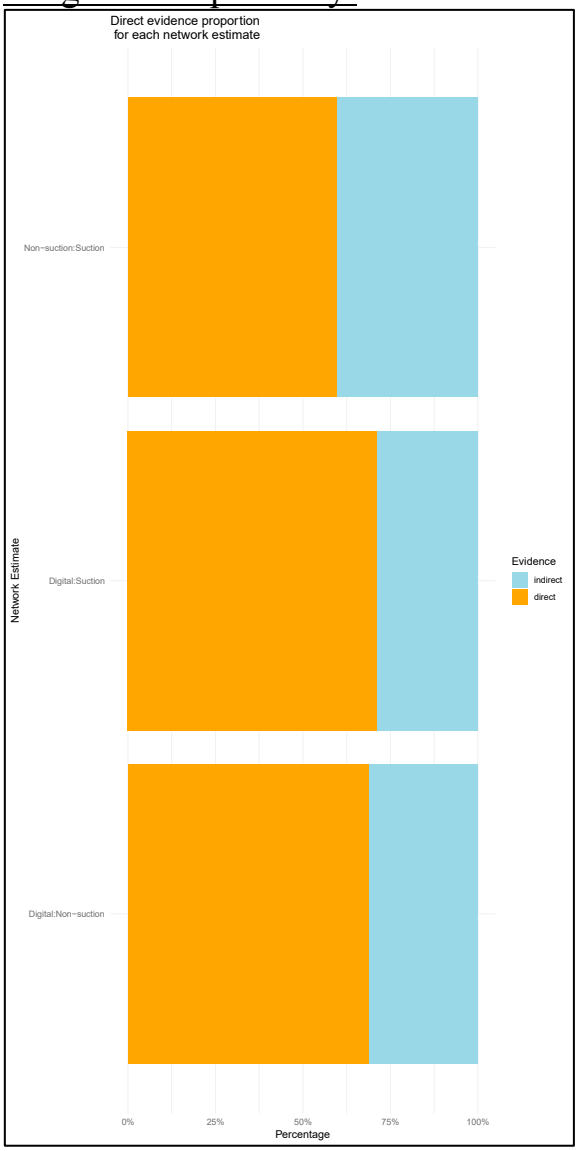
Promising Effects of Digital Chest Tube Drainage System for Pulmonary Resection: A Systematic Review and Network Meta-Analysis

Po-Chih Chang[1,2,3,4], Kai-Hua Chen[5#], Hong-Jie Jhou[6], Cho-Hao Lee[7], Shah-Hwa Chou[1,8], Po-Huang Chen[9+], Ting-Wei Chang[5*]

Contents

Supplementary Figure S1. Comparison direct and indirect evidence in network meta-analysis

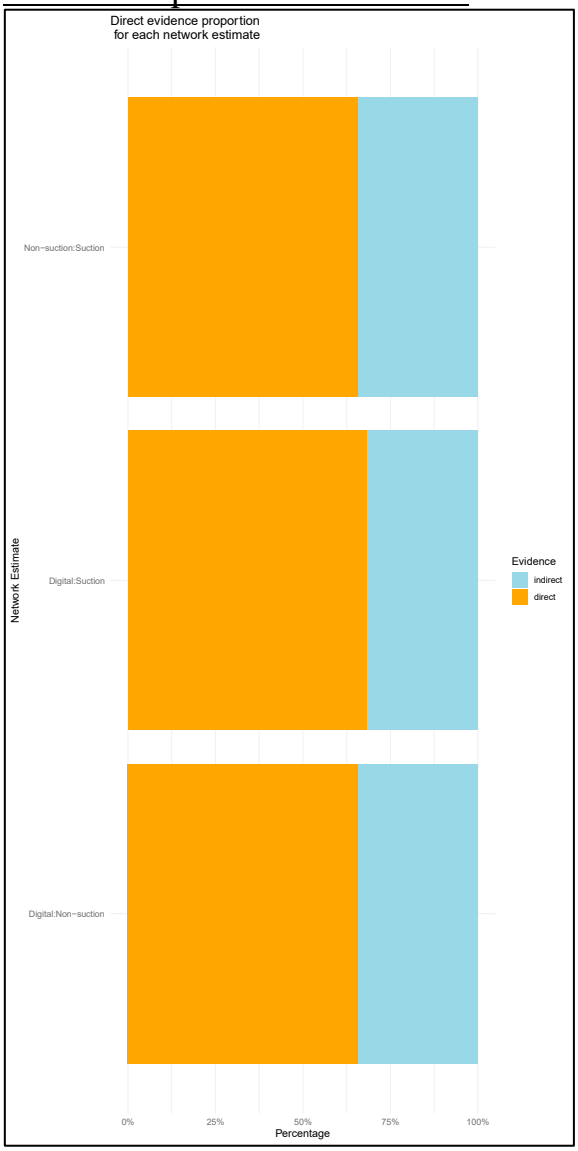
Length of hospital stay:



Supplementary Figure S1.1 Comparison direct and indirect evidence in network meta-analysis: Length of hospital stay

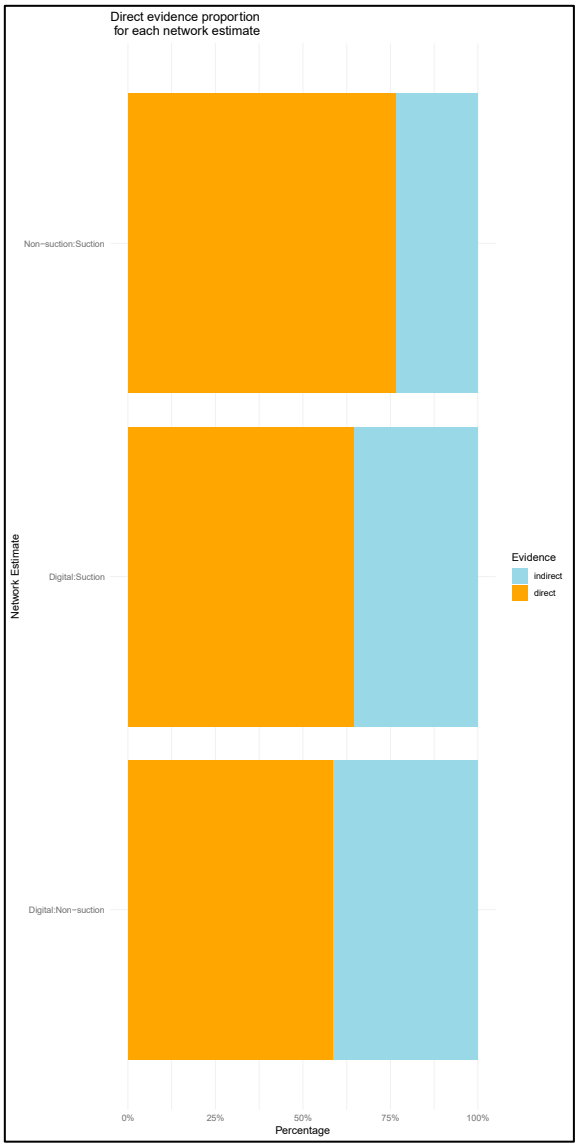
Digital, Digital chest tube drainage system; **Suction**, Suction chest tube drainage system; Non-suction, Non-suction chest tube drainage system.

Chest tube placement duration:



Supplementary Figure S1.2 Comparison direct and indirect evidence in network meta-analysis: Chest tube placement duration.
Digital, Digital chest tube drainage system; **Suction**, Suction chest tube drainage system; Non-suction, Non-suction chest tube drainage system.

Prolonged air leak:



Supplementary Figure S1.3 Comparison direct and indirect evidence in network meta-analysis: Prolonged air leak.

Digital, Digital chest tube drainage system; **Suction**, Suction chest tube drainage system; Non-suction, Non-suction chest tube drainage system.

Supplementary Figure S2. GRADE approach for rating the quality of treatment effect estimate

Supplementary Figure S2.1 Length of hospital stay

Summary of Evidence:

Promising Effects of Digital Chest Tube Drainage System for Pulmonary Resection: A Systematic Review and Network Meta-Analysis

Primary Outcome: Hospital stay

	Direct evidence		Indirect evidence		Network meta-analysis	
Comparison	Mean difference (95% CI)	Quality of evidence	Mean difference (95% CI)	Quality of evidence	Mean difference (95% CI)	Quality of evidence
Digital *v* Suction	-1.19 (-2.14 to -0.24)	**Low***	-1.90 (-3.39 to -0.41)	**Low**	-1.40 (-2.20 to -0.60)	**Low**
Digital *v* Non-suction	-0.57 (-1.55 to 0.41)	**High**	0.14 (-1.33 to 1.61)	**Low**	-0.35 (-1.17 to 0.47)	**High**
Suction *v* Non-suction	1.33 (0.21 to 2.45)	**Low***	0.63 (-0.74 to 1.99)	**Low**	1.05 (0.18 to 1.91)	**Low**

CI: Confidence interval; **Digital**, Digital chest drainage system; **Traditional**, Traditional chest drainage system; **Water-seal**, Water-seal chest drainage system

GRADE Working Group grades of evidence
High quality: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate quality: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low quality: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low quality: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations
*Limitations (risk of bias). †Inconsistency. ‡Imprecision. ¶ Indirectness because of questionable comparability of trial populations to target population of NMA or questionable outcome measurement, or intransitivity. § Greater precision. §§ Cannot be estimated because the intervention was not connected in a loop in the evidence network.

Supplementary Figure S2.2 Chest tube placement duration

Summary of Evidence:

Promising Effects of Digital Chest Tube Drainage System for Pulmonary Resection: A Systematic Review and Network Meta-Analysis

Secondary Outcome: Tube placement duration

	Direct evidence		Indirect evidence		Network meta-analysis	
Comparison	Mean difference (95% CI)	Quality of evidence	Mean difference (95% CI)	Quality of evidence	Mean difference (95% CI)	Quality of evidence
Digital *v* Suction	-0.52 (-1.30 to 0.25)	**Low***	-1.02 (-2.15 to 0.12)	**Moderate**	-0.68 (-1.32 to -0.04)	**Moderate**
Digital *v* Non-suction	-0.39 (-1.20 to 0.41)	**High**	0.10 (-1.02 to 1.21)	**High**	-0.22 (-0.88 to 0.43)	**High**
Suction *v* Non-suction	0.62 (-0.18 to 1.43)	**Moderate***	0.13 (-0.99 to 1.25)	**Low**	0.45 (-0.20 to 1.11)	**Moderate**

CI: Confidence interval; **Digital**, Digital chest drainage system; **Traditional**, Traditional chest drainage system; **Water-seal**, Water-seal chest drainage system

GRADE Working Group grades of evidence
High quality: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate quality: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low quality: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low quality: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations
*Limitations (risk of bias). †Inconsistency. ‡Imprecision. ¶ Indirectness because of questionable comparability of trial populations to target population of NMA or questionable outcome measurement, or intransitivity. § Greater precision. §§ Cannot be estimated because the intervention was not connected in a loop in the evidence network.

Supplementary Figure S2.3 Prolonged air leak

Summary of Evidence:

Promising Effects of Digital Chest Tube Drainage System for Pulmonary Resection: A Systematic Review and Network Meta-Analysis

Secondary Outcome: Prolonged air leak

	Direct evidence		Indirect evidence		Network meta-analysis	
Comparison	Odds ratio (95% CI)	Quality of evidence	Odds ratio (95% CI)	Quality of evidence	Odds ratio (95% CI)	Quality of evidence
Digital *v* Suction	0.75 (0.36 to 1.58)	**Moderate***	0.79 (0.29 to 2.17)	**Moderate**	0.76 (0.42 to 1.39)	**Moderate**
Digital *v* Non-suction	0.82 (0.36 to 1.83)	**High**	0.78 (0.30 to 2.04)	**High**	0.80 (0.43 to 1.49)	**High**
Suction *v* Non-suction	1.04 (0.57 to 1.91)	**Low***	1.09 (0.36 to 3.29)	**Low**	1.05 (0.62 to 1.79)	**Moderate**

CI: Confidence interval; **Digital**, Digital chest drainage system; **Traditional**, Traditional chest drainage system; **Water-seal**, Water-seal chest drainage system

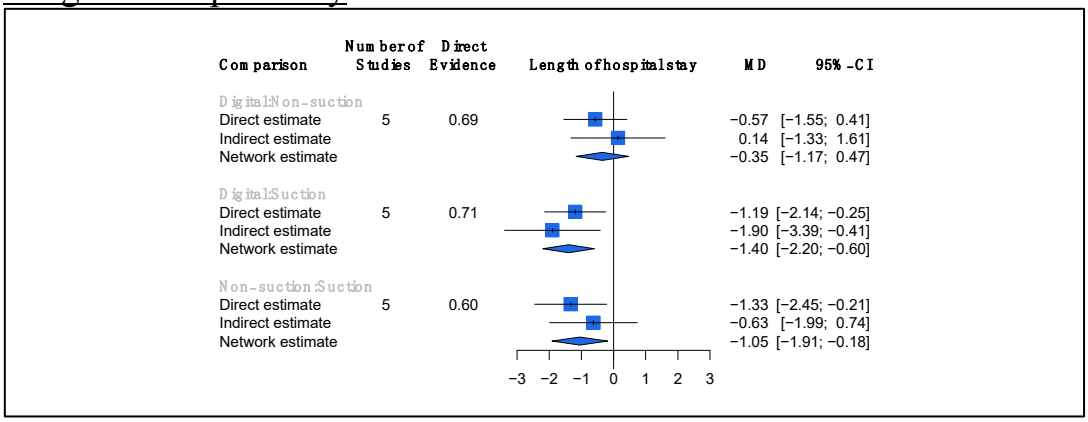
GRADE Working Group grades of evidence
High quality: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate quality: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low quality: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low quality: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Explanations

*Limitations (risk of bias). †Inconsistency. ‡Imprecision. ¶ Indirectness because of questionable comparability of trial populations to target population of NMA or questionable outcome measurement, or intransitivity. § Greater precision. §§ Cannot be estimated because the intervention was not connected in a loop in the evidence network.

Supplementary Figure S3. Results of network meta-analysis and net-split comparison

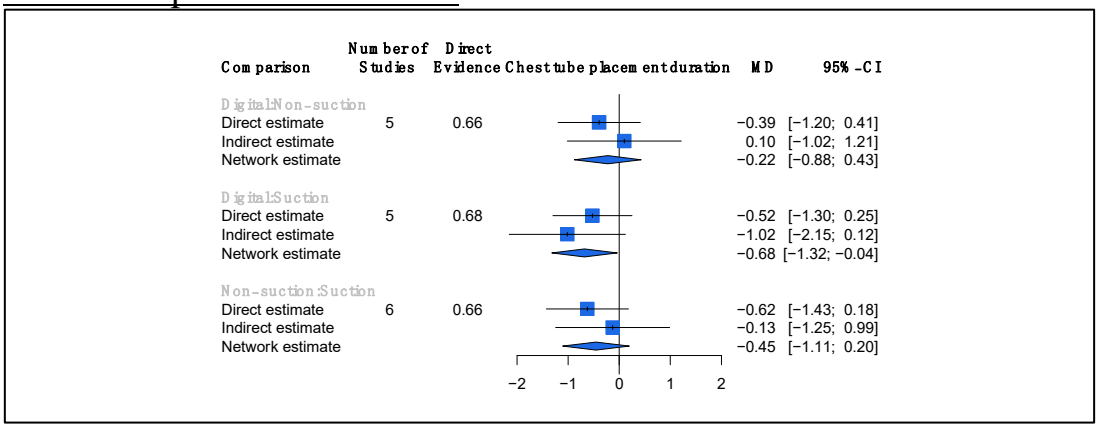
Length of hospital stay



Supplementary Figure S3.1 Results of network meta-analysis and net-split comparison: Length of hospital stay

Digital, Digital chest tube drainage system; **Suction**, Suction chest tube drainage system; **Non-suction**, Non-suction chest tube drainage system; **MD**, Mean difference; **CI**, Confident interval.

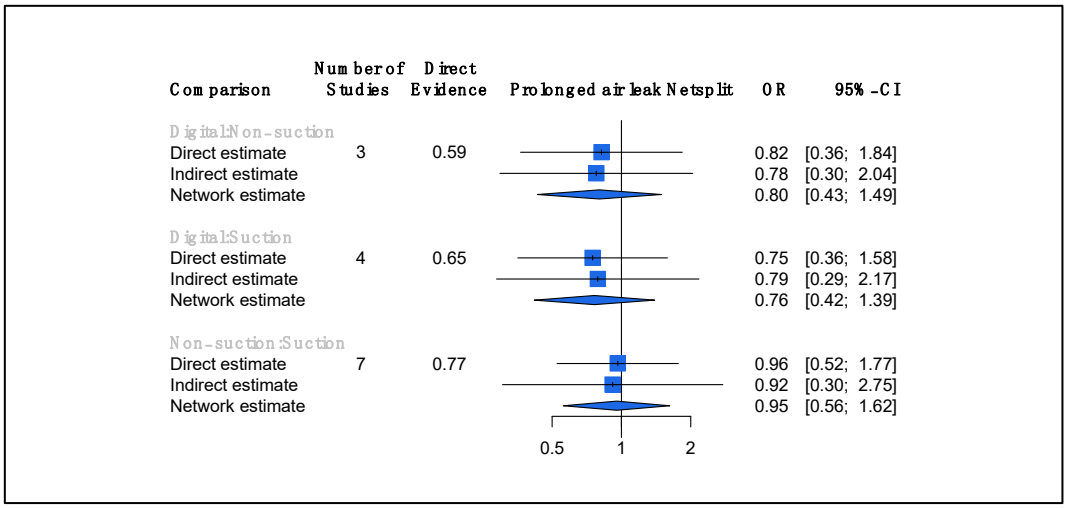
Chest tube placement duration



Supplementary Figure S3.2 Results of network meta-analysis and net-split comparison: Chest tube placement duration

Digital, Digital chest tube drainage system; **Suction**, Suction chest tube drainage system; **Non-suction**, Non-suction chest tube drainage system; **MD**, Mean difference; **CI**, Confident interval.

Prolonged air leak

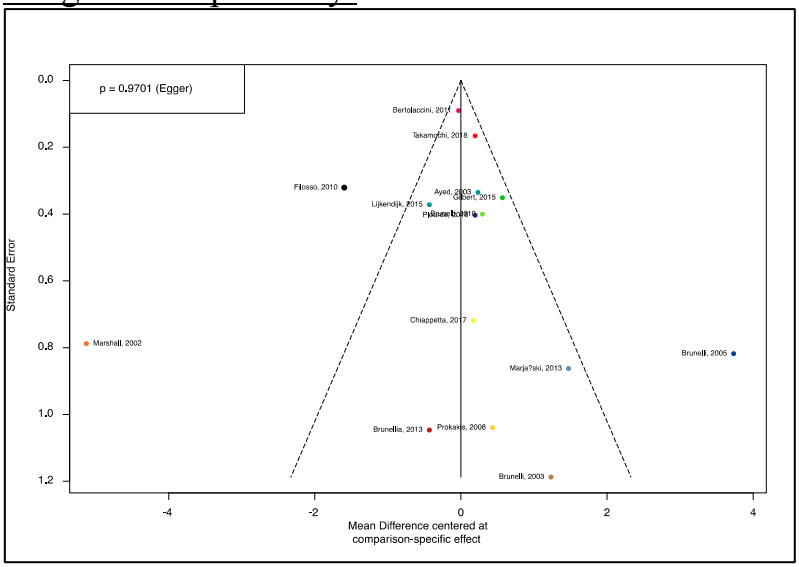


Supplementary Figure S3.3 Results of network meta-analysis and net-split comparison: Prolonged air leak

Digital, Digital chest tube drainage system; **Suction**, Suction chest tube drainage system; **Non-suction**, Non-suction chest tube drainage system; **OR**, odds ratio; **CI**, Confident interval.

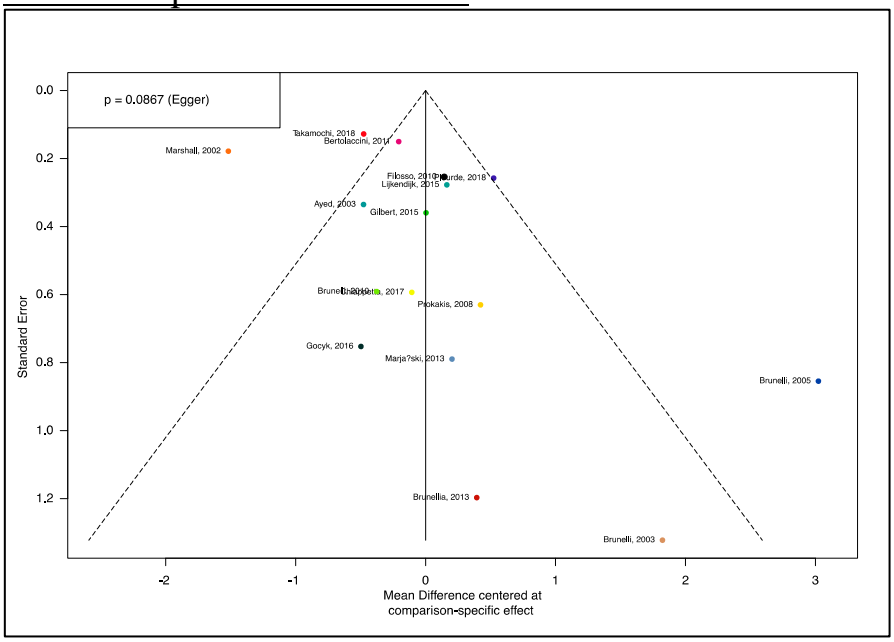
Supplementary Figure S4. Comparison-adjusted funnel plots and Egger's test

Length of hospital stay:



Supplementary Figure S4.1 Comparison-adjusted funnel plot in outcome for length of hospital stay:
Digital, Digital chest tube drainage system; **Suction**, Suction chest tube drainage system; Non-suction, Non-suction chest tube drainage system.

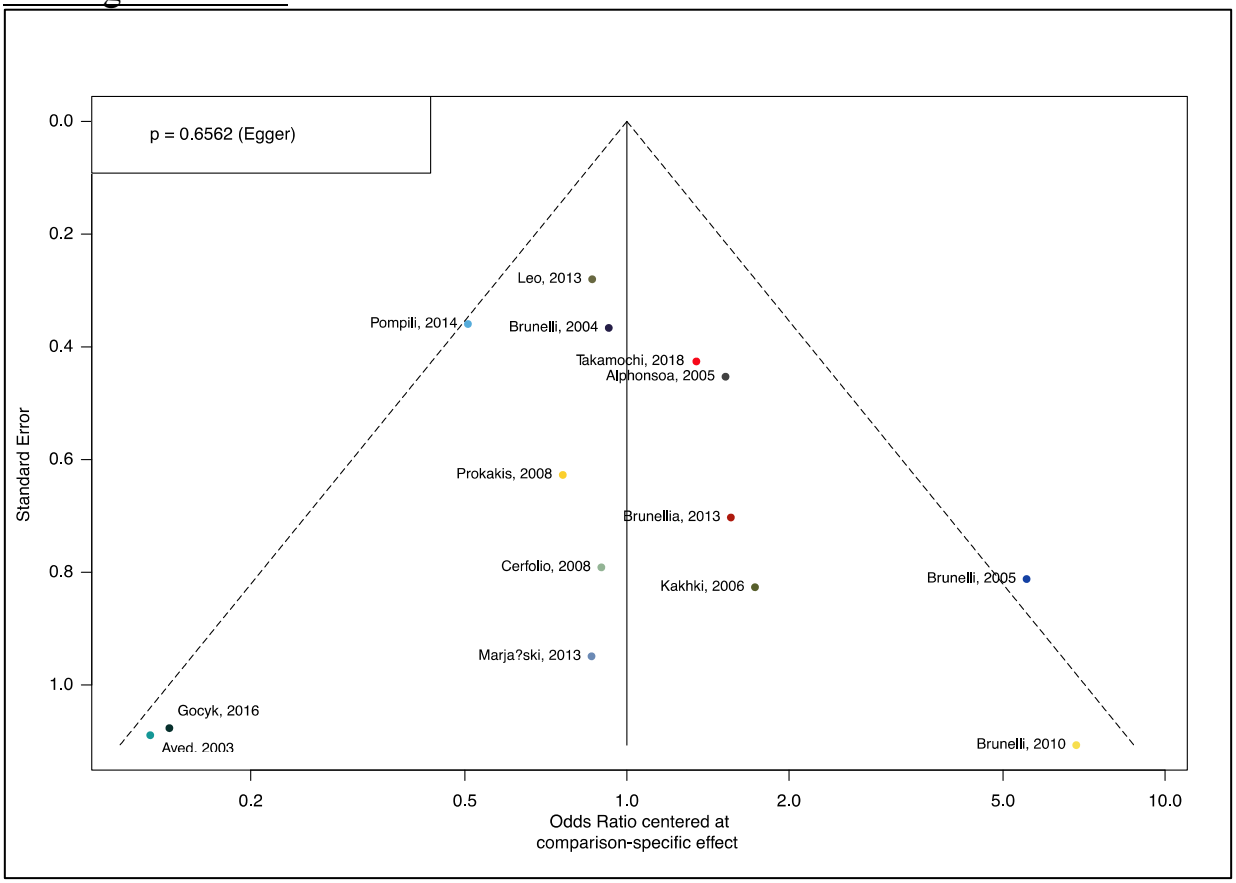
Chest tube placement duration:



Supplementary Figure S4.2 Comparison-adjusted funnel plot in outcome for chest tube placement duration:

Digital, Digital chest tube drainage system; **Suction**, Suction chest tube drainage system; **Non-suction,** Non-suction chest tube drainage system.

Prolonged air leak:



Supplementary Figure S4.3 Comparison-adjusted funnel plot in outcome for prolonged air leak:

Digital, Digital chest tube drainage system; **Suction**, Suction chest tube drainage system; **Non-suction,** Non-suction chest tube drainage system.

Supplementary Figure S5. Sensitivity analyses for the outcomes in network meta-analysis

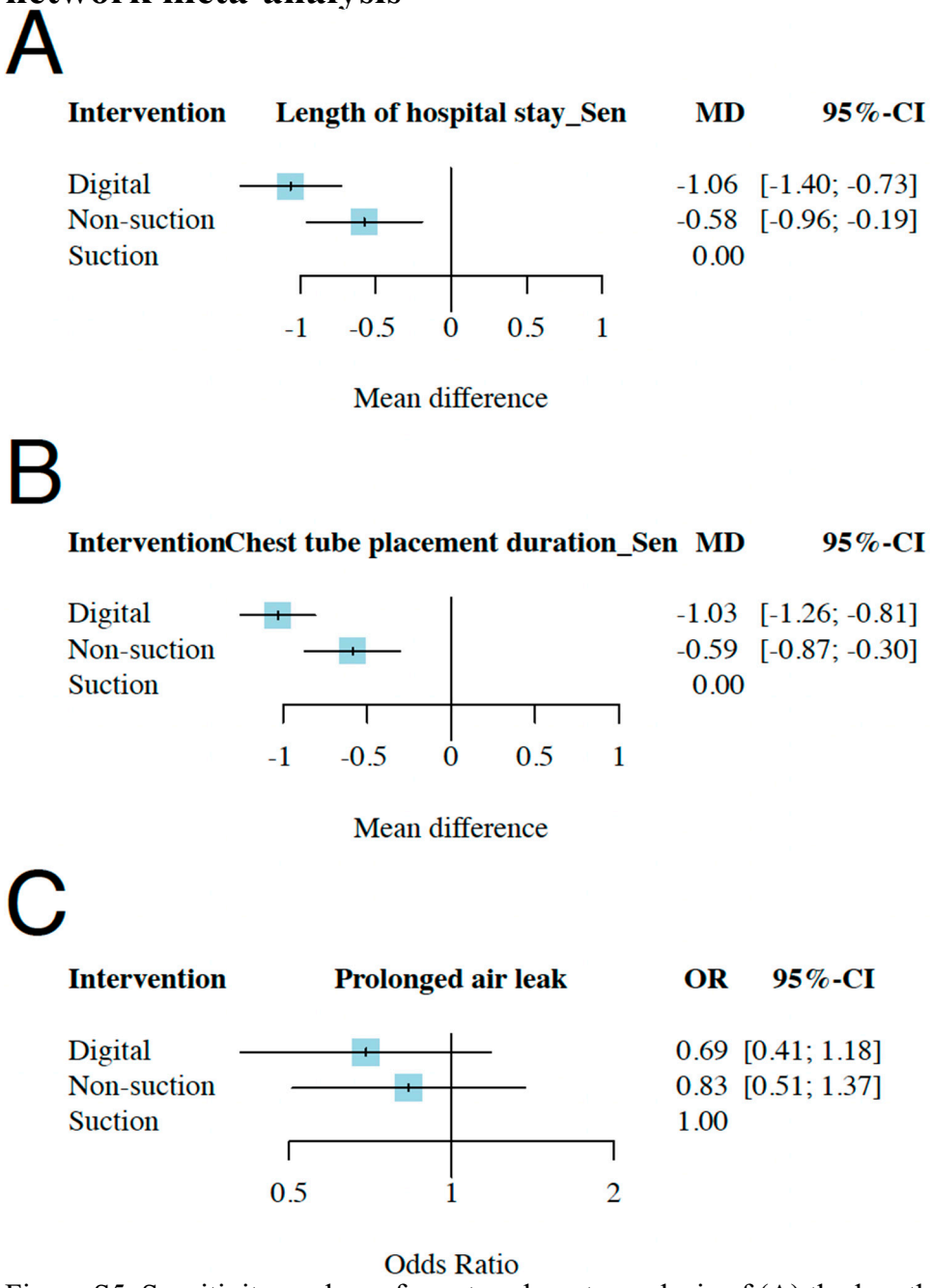


Figure S5. Sensitivity analyses for network meta-analysis of (A) the length of hospital stay, (B) the chest tube placement duration, as well as (C) the prolonged air leak.