Hôpitaux Universitaires Genève

University of Geneva Hospitals and Faculty of Medicine, Geneva, Switzerland

WHO Collaborating Centre on Infection Prevention and Control and Antimicrobial Resistance

UNIVERSITÉ DE GENÈVE

Le risque infectieux lié à l'utilisation de l'échoguidage pour la pose des cathéters centraux

Dr. med. Niccolò BUETTI, MSc PhD

IPC & ID specialist

Service PCI, Hôpitaux Universitaires de Genève (HUG)

CONTENT

- Introduction
- Literature update: anatomical landmarks' *versus* ultrasound-guidance
- Large *post-hoc* analysis conducted in French ICUs
- Conclusions

INTRODUCTION

- ICU bloodstream infections were catheter-related in 43.6% of cases
- European ICUs: the CVC utilization rate was on average 70 CVC days per 100 patient-days
- Anatomical 'landmarks' (AL) → traditionally used
- Ultrasound guidance (US) is now available and frequently used by intensivists and hospitalists:
  - 2016 survey in France (190 intensivists)
  - 18% and 50% of physicians used US "always" or "almost always"
  - (6% never, 10% almost never, 17% half of the time)

Today: probably higher use!

ECDC. Healthcare associated infections acquired in intensive care units - annual epidemiological report for 2016. Stockholm (Sweden): ECDC; 2018 // Maizel et al. Ann Intensive Care. 2016 Dec;6(1):76. doi: 10.1186/s13613-016-0177-x.

INTRODUCTION

- US and **non-infectious complications**:
  - **Outcomes mostly assessed in RCTs**
  - **Jugular** insertions:
    - US offers gains in safety and quality when compared with an anatomical landmark technique (↓ rate of total complications overall, ↑ chance of success at the first attempt, ↓ the chance of haematoma)
  - **Femoral** and **subclavian** insertions:
    - offers small gains in safety and quality when compared with an anatomical landmark technique:
      - Subclavian: ↓ arterial puncture, ↓ haematoma formation
      - Femoral vein: ↑ success on the first attempt

What about infectious risk? Frequently disregarded…

Brass P et a… …tabase Syst Rev. 2015 Jan 9;1(1):CD006962. Brass P. Et al. Cochrane Database Syst Rev. 2015 Jan 9;1(1):CD011447.

INTRODUCTION

- US and **infectious risk (hypotheses)**:
  - US may reduce the infectious risk (↑ chance of success at the first attempt → ↓ manipulations, ↓ the chance of haematoma)

BUT…

  - US may increase the infectious risk:
    - US transducer may complicate catheter insertion leading to breaches in aseptic technique

Outbreak of *Burkholderia cepacia* bacteraemia in a tertiary care centre due to contaminated ultrasound probe gel

R. Abdelfattah [a,*], S. Al-Jumaah [a], A. Al-Qahtani [b], S. Al-Thawadi [c], I. Barron [a], S. Al-Mofada [d]

[a] *Department of Infection Control and Hospital Epidemiology, King Faisal Specialist Hospital and Research Center, Riyadh, Saudi Arabia*
[b] *Department of Infection and Immunity, Research Center, King Faisal Specialist Hospital and Research Center, Riyadh, Saudi Arabia*
[c] *Pathology & Laboratory Medicine Department, King Faisal Specialist Hospital and Research Center, Riyadh, Saudi Arabia*
[d] *Infection Control Committee, King Faisal Specialist Hospital and Research Center, Riyadh, Saudi Arabia*

Findings: *B. cepacia* was isolated from the blood cultures of 14 patients resulting from contamination of the gel applied to the ultrasound probe used to guide the insertion of a central venous catheter. Molecular pathogen typing using pulsed-field gel electrophoresis showed 95% similarity between the *B. cepacia* isolates from the blood of these patients and those isolated from the ultrasound gel.

Conclusion: Ongoing surveillance and prompt investigation of unusual disease outbreaks are vital for identifying sources of contamination of *B. cepacia* and protecting at-risk patients. Sound epidemiological methods are very important for identifying the source of any hospital infection outbreak.

Abdelfattah R et al. Journal of Hospital Infection 98 (2018) 289e294

INTRODUCTION

- US and **infectious risk**:
  - US may reduce the infectious risk (↑ chance of success at the first attempt → ↓ manipulations, ↓ the chance of haematoma)

  BUT…
  - US may increase the infectious risk:
    - US transducer may complicate catheter insertion leading to breaches in aseptic technique
    - Risk of outbreaks due to contaminated US gel
    - **Impact of US on catheter care → dressing disruptions?**

Abdelfattah R et al. Journal of Hospital Infection 98 (2018) 289e294

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LITERATURE UPDATE

- US and **infectious risk**: data from RCTs
  - Large SR & MA 2015 [until 2013]:
    - CRBSI was not investigated as a primary outcome in any of the reviewed studies
    - Only two studies reported rates of intravascular catheter infections
  - Re-run SR until beginning of 2022 [personal data NB]:
    - (Five) studies, >1200 CVC insertions
    - Studies mostly focus on jugular insertions

Brass P et al. Cochrane Database Syst Rev. 2015 Jan 9;1(1):CD006962. Brass P. Et al. Cochrane Database Syst Rev. 2015 Jan 9;1(1):CD011447.

LITERATURE UPDATE

- US and **infectious risk**: data from RCTs

Karakitsos 2006	
Methods	Randomised controlled study / Years **2000-2006**
Participants	900 mechanical ventilated patients requiring CVCs for difficult peripheral venous access, need for invasive haemodynamic monitoring and delivery of inotropic medications or antibiotics in a medical and surgical ICU Intervention AL (n=450) versus US (n=450). Only **internal jugular** vein.
Outcomes	Access time, the average number of attempts before successful placement (defined as separat… punctures), the … …itions
Infe	

Elevated CRBSI rates! Could reflect clinical practices prior to routine implementation of prevention-bundles?

Karakitsos et al. Crit Care. 2006;10(6):R162.

LITERATURE UPDATE

- US and **infectious risk**: data from RCTs

Gok 2013	
Methods	Prospective randomised **single-centre** study
Years	**2011-2013**
Participants	Patients suffering cardiac arrest, congestive cardiac failure, acute pulmonary embolism, ARDS, postoperative respiratory failure, trauma, neuromuscular disease, cerebrovascular accident, metabolic disease, organophosphorus poisoning and catheterization was performed for the purpose of intravenous fluids, inotropic agent infusion, total parenteral nutrition and hemodynamic monitoring. All [illegible] sedated and [illegible]
In	[illegible] on [illegible] time, time for insertion, [illegible] mechanical complications. The authors used IDSA CRBSI definitions.
Inf	**AL: CVC-BSI 10.3% (10/97) and US: CVC BSI 2% (2/97)**

…performed by a single operator…
…disproportionately high infectious and mechanical complications (29%) in the AL group…

Gok F et al. Acta Medica Mediterranea, 2013, 29: 677

LITERATURE UPDATE

- US and **infectious risk**: data from RCTs

Dolu 2015	
Methods	Prospective randomised **single-centre** study
Years	**2010-2011**
Participants	Patients who required elective cardiovascular surgery Intervention **50 patients with US catheter insertion vs 50 patients** with AL catheter insertion. Only internal jugular catheters.
Outcomes	Number of n… e duration of procedure. …ere not defined.

!…NO CRBSI…!

Dolu H et al. J Clin Monit Comput. DOI 10.1007/s10877-014-9585-3

LITERATURE UPDATE

- US and **infectious risk**: data from RCTs

Tagliari 2015	
Methods Prospective randomised **single-centre** study	
Years	**2014-2015**
Participants	Adult patients affected by several different **neoplastic diseases requiring chemotherapy**.
Intervention	One hundred ten patients with indication of intravenous chemotherapy were randomly assigned to TIVAD implant through US internal jugular vein (USG) puncture (39) or internal jugular vein blindly (IJB) (36) or subclavian vein blindly (SCB) (35). Outcomes The primary outcome was the combination of pneumothorax, local hematoma, arterial puncture, and hemothorax (immediate complications). The secondary outcomes were first attempt success, technique failure (need to change puncture side or puncture technique), and the co[illegible]ion of subcutaneous pocket [illegible]ection, venous thrombosis, [illegible]er fracture, port extrusion, [illegible]ction (early complications). **intravascular catheter infections were not defined**.

!…NO CRBSI…!

Tagliari AP et al. Journal of Surgical Oncology 2015;112:56–59

LITERATURE UPDATE

- US and **infectious risk (colonization)**: data from RCTs

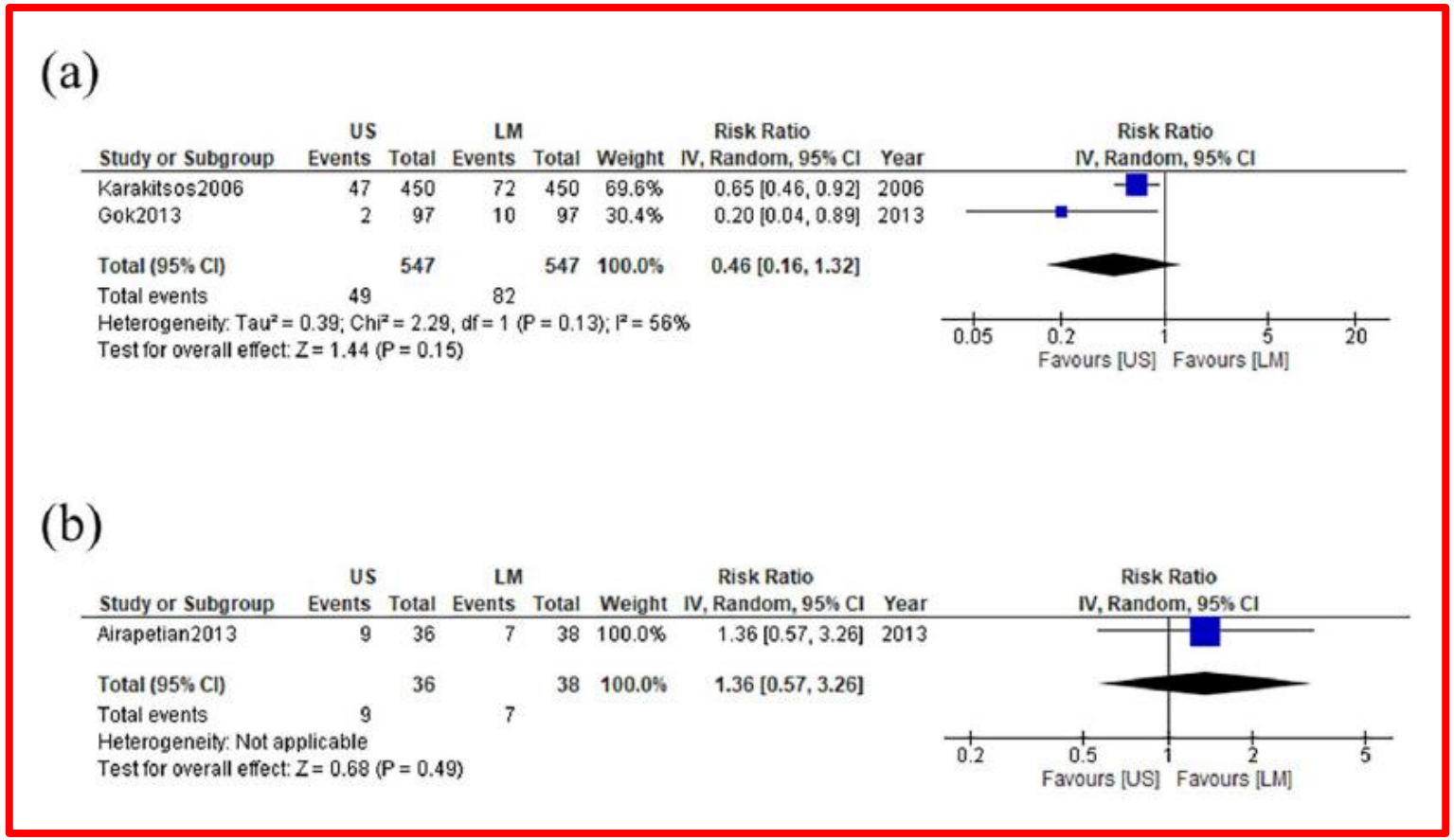
Airapetian 2013	
Methods	**Landmark (LM)** *versus* **ultrasound with skin mark** *versus* **ultrasound-guided (UG)** cannulation. Jugular and femoral veins (inexperienced operators)
Design	Prospective randomized single-center study.
Results	signed to the three groups
Colonization	

!…NO CRBSI…!

Airapetian et al. Intensive Care Med (2013) 39:1938–1944

LITERATURE UPDATE

- US and **infectious risk:** data from RCTs



Takeshita et al. BMC Infectious Diseases (2022) 22:772

LITERATURE UPDATE

- US and **infectious risk**: observational studies

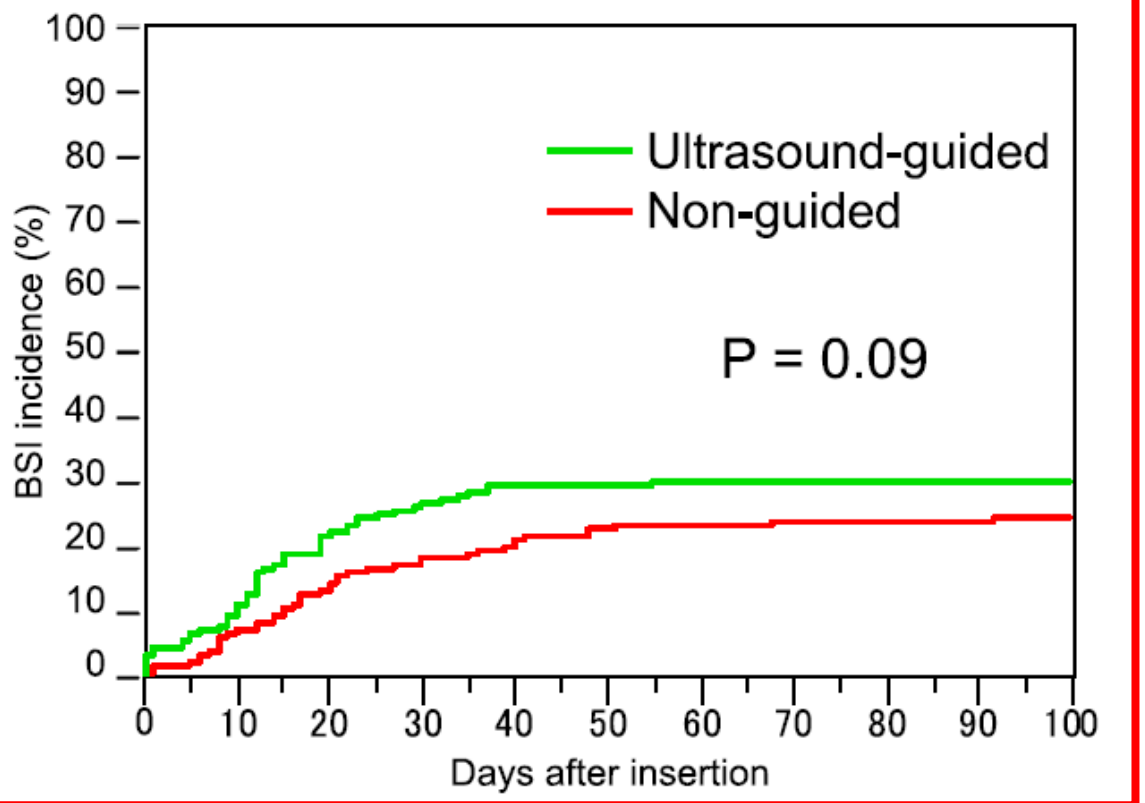
No association between ultrasound-guided insertion of central venous catheters and bloodstream infection: a prospective observational study

V. Cartier [a], A. Haenny [a], C. Inan [a], B. Walder [a], W. Zingg [b,*]

[a] *Division of Anaesthesiology, University Hospitals of Geneva, Geneva, Switzerland*
[b] *Infection Control Programme, University Hospitals of Geneva, Geneva, Switzerland*

CABSI

Variable	Univariate model		
	HR	95% CI	*P*-value
Ultrasound[a]	0.67	0.36–1.25	0.211
Jugular vein[a]	0.65	0.36–1.17	0.149
Subclavian vein	1.17	0.64–2.14	0.612
Femoral vein[a]	5.35	2.03–14.09	0.001
Other catheter type[a,b]	2.81	1.12–7.05	0.028
Multiple lumens	0.96	0.51–1.78	0.890
Urgent CVC insertion	0.75	0.40–1.39	0.356
Age[c]	0.97	0.88–1.07	0.564
Sex	1.23	0.69–2.18	0.487
ASA score >3	0.57	0.17–1.90	0.358
Charlson comorbidity index >3	0.97	0.55–1.72	0.920
Emergency admission	0.64	0.29–1.44	0.284
Prior surgery	1.16	0.59–2.30	0.662



Cartier et al. Journal of Hospital Infection 87 (2014) 103e108 // Imataki et al. BMC Infectious Diseases (2019) 19:857

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US *versus* AL: large study

Clinical Infectious Diseases

MAJOR ARTICLE

Ultrasound Guidance and Risk for Central Venous Catheter–Related Infections in the Intensive Care Unit: A Post Hoc Analysis of Individual Data of 3 Multicenter Randomized Trials

Niccolò Buetti,[1,2] Olivier Mimoz,[3] Leonard Mermel,[4] Stéphane Ruckly,[1] Nicolas Mongardon,[5] Claire Dupuis,[1] Jean-Paul Mira,[6] Jean-Christophe Lucet,[1,7] Bruno Mégarbane,[8] Sébastien Bailly,[9] Jean-Jacques Parienti,[10,11] and Jean-François Timsit[1,12]

Buetti N. et al. Clin Infect Dis. 2021 Sep 7;73(5):e1054-e1061

US *versus* AL: large study

- **Objective:** To generate new evidence regarding infectious risk associated with US (*versus* AL)
- **Methods:**
  - Merging three high quality databases from three large prospective RCTs
    - DRESSING2 study: CHG-gel *versus* standard dressings → infections?
    - CLEAN study: PVI *versus* alcoholic 2% CHG → infections?
    - 3SITES study: jugular *versus* femoral versus subclavian insertions → complications?
  - Adult patients who needed an intravascular catheter (2010-2014)
  - Ultrasound utilization: variable routinely collected
  - Outcomes:
    - Catheter-related bloodstream infection (CRBSI)
    - Major Catheter-related infection (MCRI)
    - Insertion site colonization at the time of catheter removal

Buetti N. et al. Clin Infect Dis. 2021 Sep 7;73(5):e1054-e1061

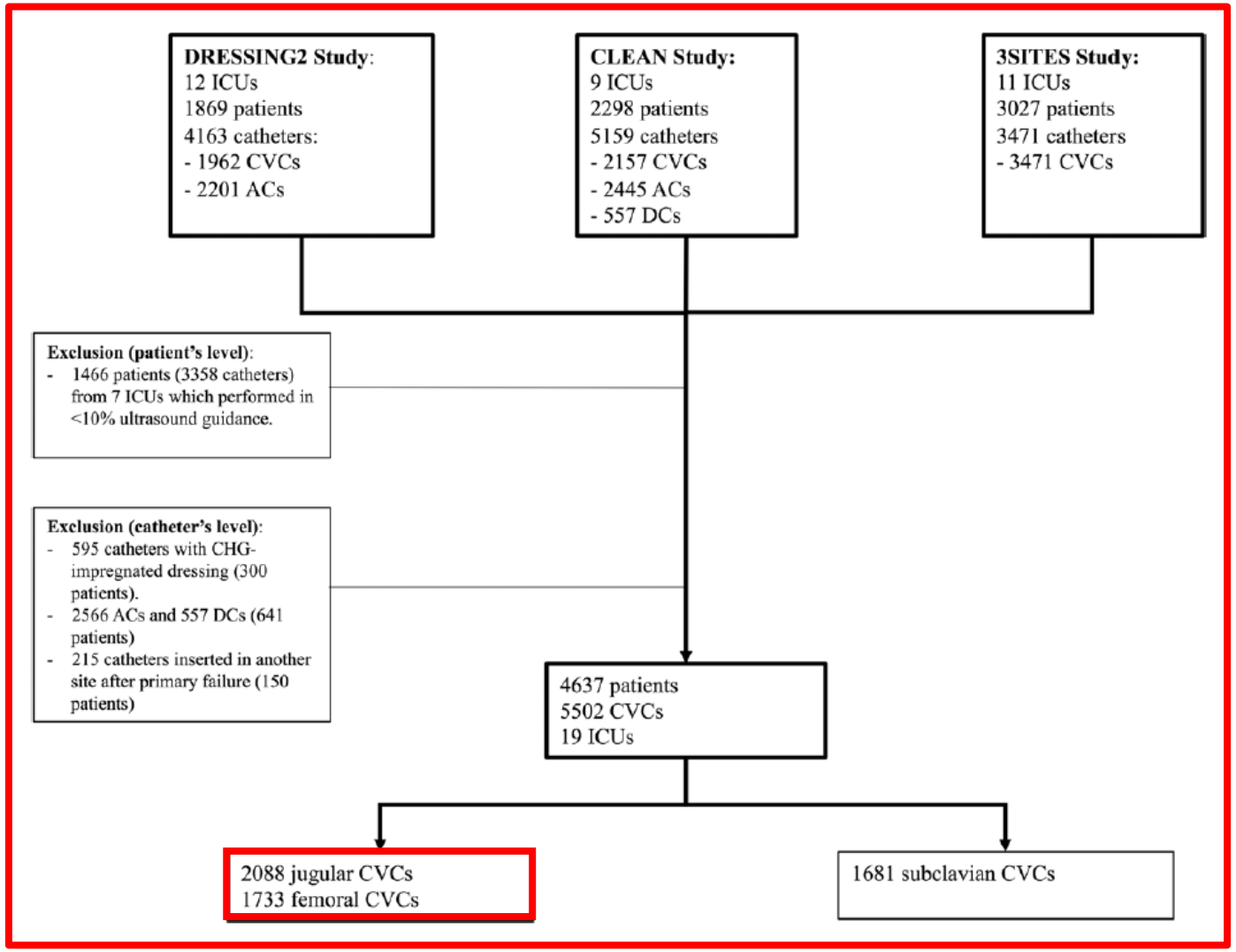
US *versus* AL: large study

- **Methods (statistics):**
  - Propensity score aimed to predict the conditional probability that a given catheter would be inserted using US guidance, using variables recorded before and at the time of catheter insertion
  - Focus on jugular & femoral insertions
    - But several sub-analyses for different sites
  - Marginal Cox models weighted by IPTW and stratified by center

Buetti N. et al. Clin Infect Dis. 2021 Sep 7;73(5):e1054-e1061

US *versus* AL: large study

- **Results:**



Buetti N. et al. Clin Infect Dis. 2021 Sep 7;73(5):e1054-e1061

US *versus* AL: large study

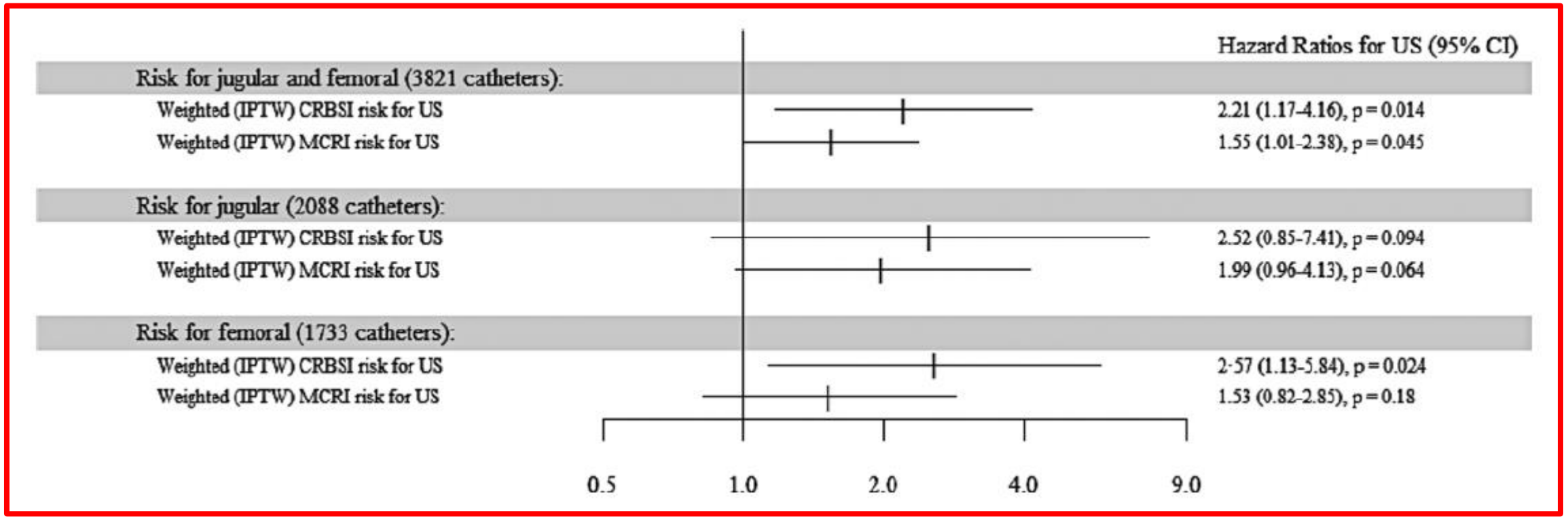
- **Results:**

Characteristic	All	AL	US
Patient characteristics	**(n = 4637)**	**(n = 2885)**	**(n = 1752)**
Sex			
Female	1646 (35.5)	1022 (35.4)	624 (35.6)
Male	2991 (64.5)	1863 (64.6)	1128 (64.4)
Age, y, median (IQR)	64 (52.7–75)	64 (51.9–74.4)	64 (54–75.9)
Chronic renal failure	328 (7.1)	210 (7.3)	118 (6.7)
Diabetes mellitus	720 (15.5)	440 (15.3)	280 (16)
Chronic respiratory failure	465 (10)	267 (9.3)	198 (11.3)
Neoplasia	482 (10.4)	301 (10.4)	181 (10.3)
Immunosuppression	882 (19)	545 (18.9)	337 (19.2)
SAPS II, median (IQR)	54 (41–68)	55 (42–69)	53 (41–67.5)
Catheter-related variables	**All (n = 5502)**	**AL (n = 3355)**	**US (n = 2147)**
Catheter-days, median (IQR)	6 (3–10)	6 (3–10)	6 (3–10)
Time from ICU admission to catheter insertion, median (IQR)	1 (1–4)	1 (1–5)	1 (1–4)
Experience of the operator			
<50 procedures	3777 (68.6)	2284 (68.1)	1493 (69.5)
≥50 procedures	1725 (31.4)	1071 (31.9)	654 (30.5)
Insertion site			
Jugular	2088 (37.9)	635 (18.9)	1453 (67.7)
Subclavian	1681 (30.6)	1466 (43.7)	215 (10)
Femoral	1733 (31.5)	1254 (37.4)	479 (22.3)
Right side jugular	1470 (70.4)	463 (72.9)	1007 (69.3)
Right side femoral	1037 (59.8)	754 (60.1)	283 (59.1)
Skin antisepsis			
Non-CHG	3004 (54.6)	1879 (56)	1125 (52.4)
CHG	2498 (45.4)	1476 (44)	1022 (47.6)
Mechanical ventilation at insertion	4341 (78.9)	2684 (80)	1657 (77.2)
Vasopressor at insertion	3340 (60.7)	1986 (59.2)	1354 (63.1)
Antibiotics at insertion	3234 (58.8)	1938 (57.8)	1296 (60.4)
Heparin	2715 (49.3)	1648 (49.1)	1067 (49.7)
Lipids	1197 (21.8)	738 (22)	459 (21.4)

Buetti N. et al. Clin Infect Dis. 2021 Sep 7;73(5):e1054-e1061

US *versus* AL: large study

- **Results:**



Buetti N. et al. Clin Infect Dis. 2021 Sep 7;73(5):e1054-e1061

US *versus* AL: large study

- **Results (skin colonization at removal):**

Colonization	AL	US	*P* Value[a]
Skin colonization at removal (n = 941)			
High colonization	183 (43.3)	253 (48.8)	.10
Low colonization	159 (37.6)	161 (31.1)	
Sterile	81 (19.1)	104 (20.1)	
Skin colonization at removal for ≤7 catheter-days (n = 606)			
High colonization	106 (37.3)	150 (46.6)	.0045
Low colonization	120 (42.3)	95 (29.5)	
Sterile	58 (20.4)	77 (23.9)	
Skin colonization at removal for >7 catheter-days (n = 335)			
High colonization	77 (55.4)	103 (52.6)	.51
Low colonization	39 (28.1)	66 (33.7)	
Sterile	23 (16.5)	27 (13.8)	

NB: sub-analysis of 3SITES cohort: AL with tedency towards more hematomas and symptomatic thrombosis

Buetti N. et al. Clin Infect Dis. 2021 Sep 7;73(5):e1054-e1061

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CONCLUSIONS

The debate is (still) open:

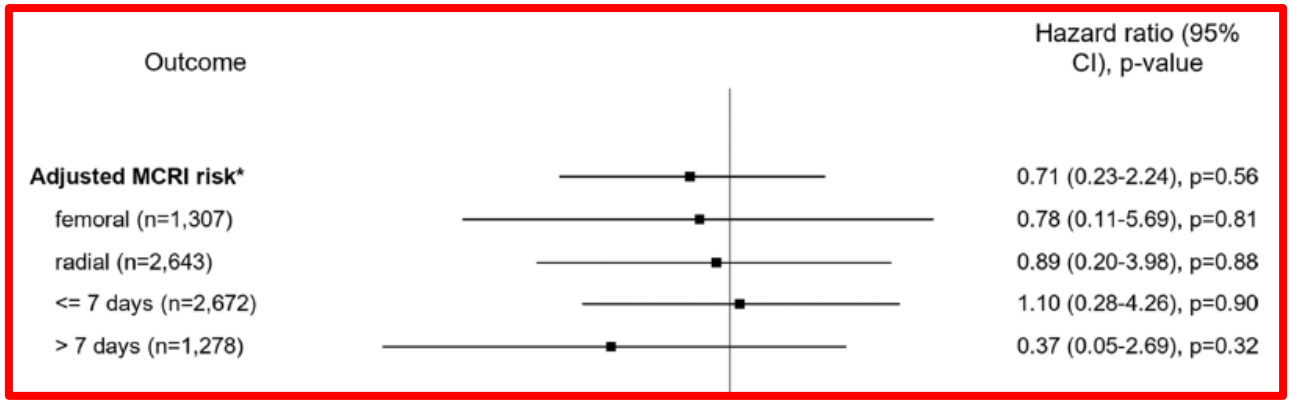
- Non-infectious complications:
  - ↑ chance of success at the first attempt, ↓ the chance of haematoma, ↓ thrombosis (?), ↓ arterial puncture
- Insufficient data from RCTs regarding infectious risk
  - tendency → ↓ infections with US
  - CAVE: **old old** data!
- A large RCT that assesses the infectious risk is <u>not</u> currently planned
- New (observational) studies suggest a possible increased risk with US:
  - Residual confounding!
  - **Old** data (until 2014)!
  - Knowledge on US utilization was (maybe) lacking

Franco-Sadud R et al. Position statement of the Society of Hospital Medicine. J Hosp Med 2019; 14:E1–22. Brass P et al. Cochrane Database Syst Rev. 2015 Jan 9;1(1):CD006962. Brass P. Et al. Cochrane Database Syst Rev. 2015 Jan 9;1(1):CD011447.

CONCLUSIONS

The debate is (still) open:

- What about the impact of US on non-ICU patients?
  - Probably impact ↓ ↓ important (non-urgent placement, catheter-duration shorter compared to critically ill patient)
- What about other catheter types?
  - US probably did not increase infectious risk among arterial catheters



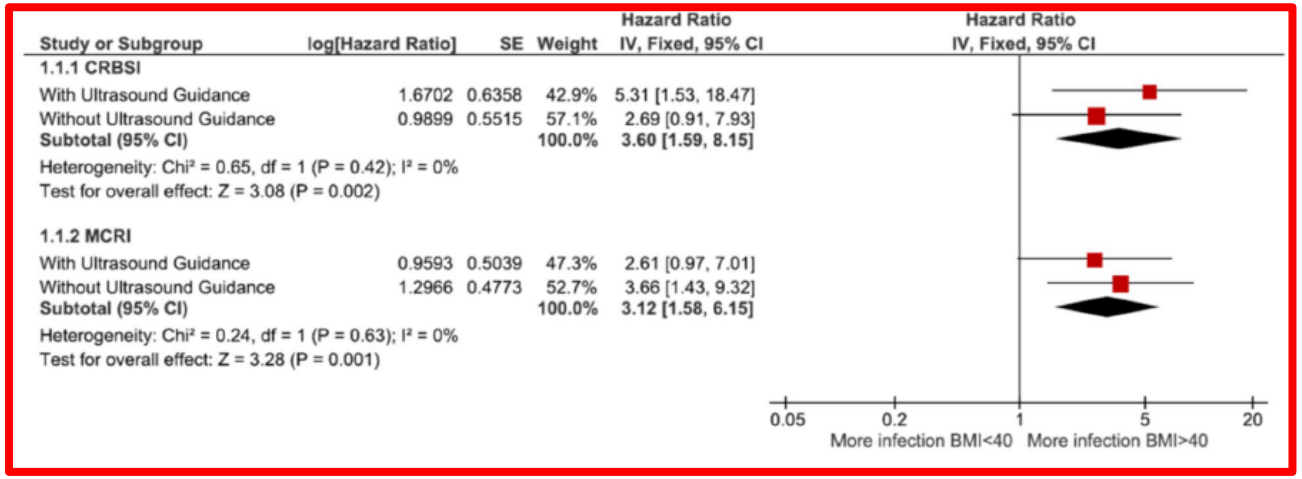
  - What about PICC or midlines (or PVC)?

Buetti N. et al. Ann Intensive Care. 2020 Jul 8;10(1):89.

CONCLUSIONS

The debate is (still) open:

- What about severe obese patients (BMI ≥40)?
  - US probably did not reduce infectious risk in severe obese patients



- Is IPC knowledge better today?
  - CAVE: Evidence-based recommendations on the use of US guidance for CVC insertion in adult patients have been only recently published

Buetti N et al. Intensive Care Med. 2021 May;47(5):632-634 // Franco-Sadud R et al. Position statement of the Society of Hospital Medicine. J Hosp Med 2019; 14:E1–22.

CONCLUSIONS

Please pay attention to IPC measures:

Table 3. Key Points for Optimal Ultrasound-Guided Central Venous Catheter Insertion With Focus on Infection Prevention Measures

1. Preprocedure
Operators should be familiar with the operation of their specific US machine prior to initiation of a vascular access procedure.
Use a high-frequency linear transducer with a long sterile sheath to perform vascular access procedures.
Use single-use sterile transmission gel.
Operators should evaluate the target blood vessel size and depth during preprocedural ultrasound evaluation.
2. Techniques
Operators should use a standardized procedure checklist that includes the use of real-time US guidance.
US guidance should be combined with aseptic technique and maximal sterile barrier precautions.
The needle tip should never be in contact with the sterile sheath of transducer.
3. Training
Novice operators should complete a systematic training program before attempting US-guided CVC insertion independently on patients.
Cognitive training in US guided CVC insertion should include infection prevention strategies.
Trainees should demonstrate minimal competence in infection prevention measures before placing US-guided CVCs independently.
Competency assessments should include formal evaluation of knowledge in infection prevention measures using standardized assessment tools.
Periodic proficiency assessment of all operators should be conducted to ensure maintenance of competency.

Buetti N. et al. Clin Infect Dis. 2021 Sep 7;73(5):e1054-e1061 // Franco-Sadud R et al. Position statement of the Society of Hospital Medicine. J Hosp Med 2019; 14:E1–22.

niccolo.buetti@gmail.com
niccolo.buetti@hcuge.ch