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ESO Guideline on Stroke-Associated Pneumonia

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Introduction

- Post-stroke infections (UTI, SAP) are common complications
- SAP affects ~12% of patients
- Associated with high in-hospital mortality (~22%), longer hospital stay, with poorer long-term neurological outcomes, and higher costs
- Caused by dysphagia, aspiration, and stroke-induced immunodepression
- Typically occurs within 2 – 5 days post-stroke → key prevention window
- No dedicated evidence-based SAP guideline currently available
- Dysphagia management excluded ← addressed in a separate ESO guideline *

for a review: Westendorp, Dames, Nederkoorn, Meisel. *Stroke* (2022); * Dziewas et al. *Eur Stroke J* (2021)

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Evidence-based recommendation

15 PICO Questions

Population:	- **1-11)** Hospitalised adults with acute ischaemic or haemorrhagic stroke (non-ventilated) within 7 days of stroke symptoms onset - **12-15)** Hospitalised adults with SAP (ischaemic or haemorrhagic stroke; non-ventilated) within 7 days of stroke symptoms onset
Intervention - **Diagnosis**:	**1)** Standardised diagnostic criteria; **2)** Chest CT or Chest ultrasound; **3)** Biomarker
Intervention - **Prediction**:	**4)** Biomarkers or Scores; **5)** Biomarker / Score-guided antibiotic treatment
Intervention - **Prevention**:	**6)** Preventive antibiotic treatment**;** **7)** Specific drugs (e.g. metoclopramid, beta-blockers); **8)** Intermittent vs. continuous nasogastric tube feeding; **9)** respiratory physiotherapy; **10)** Early mobilisation; **11)** Positioning (for unconscious patients)
Intervention - **Treatment:**	**12)** Longer duration of antibiotic treatment (>7d); **13)** broad spectrum antibiotics; **14)** Guided by identification of microbiologic aetiology; **15)** Use of adjuncts (e.g. cough assisted device, breathing therapy)
Comparison:	Standard treatment
Outcome:	- Clinical outcomes (e.g. mRS, Barthel Index, survival) at 3 month - Complications (e.g. vascular, other/recurent infection, seizures) - SAP

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Evidence-based Recommendations (Prediction)

Scores and biomarkers to identify patients at risk for SAP

PICO 4 In hospitalised adults with acute ischaemic or haemorrhagic stroke (non-ventilated) within 7 days of stroke symptom onset, does use of clinical prediction scores or biomarkers, compared to not using clinical prediction scores or biomarkers, identify patients who will develop SAP?

Evidence-based Recommendations	Quality of evidence	Strength
In hospitalized, non-ventilated patients with acute ischaemic or haemorrhagic stroke within 7 days of stroke symptom onset, clinical prediction scores and selected biomarkers may help identify individuals at increased risk of developing SAP, with moderate to good discriminatory performance. However, there is currently insufficient evidence to support the routine combination of biomarkers with existing clinical prediction tools for risk stratification. Continued uncertainty remains regarding the incremental clinical value of these approaches, and their implementation will ultimately depend on the availability, feasibility, and effectiveness of targeted preventive interventions. Please see the Expert Consensus Statement below.	⊕	↑?

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Meta-analysis of the predictive performance of SAP risk scores in external validation

Components of risk scores for predicting SAP

	ISAN	A2DS2	AIS-APS	PANTHERIS	PASS
Age	✓	✓	✓	✓	✓
NIHSS	✓	✓	✓		✓
GCS			✓	✓	
Sex	✓	✓			✓
Dysphagia		✓	✓		✓
OCSP subtype			✓		
Increase in systolic BP > 200 mmHg				✓	
Pre-stroke dependence (mRS)	✓		✓		✓
Atrial fibrillation		✓	✓		
Congestive cardiac failure			✓		
COPD			✓		✓
Current smoking			✓		
Diabetes					✓
Blood glucose (mmol/l)			✓		
WBC count/µl				✓	
Stroke type (ischaemic / haemorrhagic)					✓

Predictive performance in external validation

Score	Number of studies	ROC	SE	95% CI	Q	I^2	Egger's test
A2DS2	22	0.800	0.010	0.78 to 0.82	331.66	93.7%	0.505
A2DS2 modified	8	0.881	0.016	0.85 to 0.92	61.24	88.6%	0.833
ISAN	13	0.779	0.010	0.76 to 0.80	69.90	82.8%	0.441
AIS-APS	6	0.783	0.009	0.77 to 0.80	11.43	56.3%	0.949
PANTHERIS	4	0.725	0.028	0.67 to 0.78	29.35	89.8%	0.270
PASS	4	0.745	0.029	0.69 to 0.80	100.10	97.0%	0.190

- A2DS2 (modified version) shows the best performance
- High heterogeneity is the main limitation
- No clear evidence of publication bias

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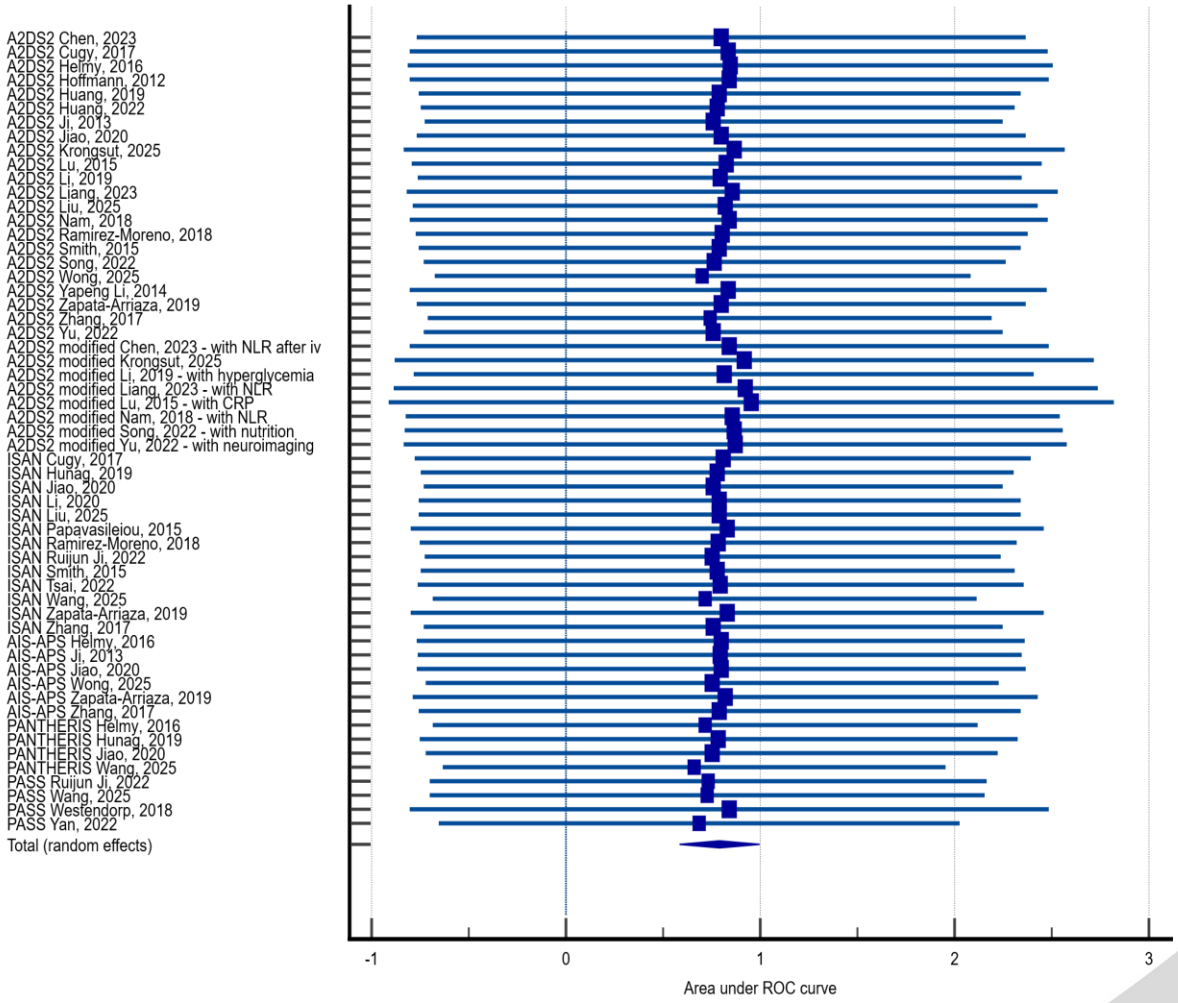
Risk-of-bias assessment and Forest plot of studies investigating predicting scores for SAP

Study	Participants	Predictors	Outcome	Analysis	Overall Risk of Bias	Applicability Concerns
Chen, 2023 (35)	-	+	+	-	-	+
Cugy, 2017 (36)	+	+	-	x	x	-
Helmy, 2016 (37)	-	+	+	-	-	+
Hoffmann, 2012 (38)	-	-	-	x	x	-
Huang, 2019 (39)	+	+	+	-	-	+
Huang, 2022 (50)	+	+	+	+	+	+
Ji, 2013 (40)	+	+	+	-	-	+
Jiao, 2020 (41)	+	+	+	-	-	+
Ji, 2022 (Ruijun) (57)	+	+	+	+	+	+
Krongsut, 2025 (53)	-	+	+	-	-	-
Li, 2014 (Yapeng) (48)	-	-	-	x	x	-
Li, 2019 (43)	-	-	+	-	-	-
Li, 2020 (61)	+	+	+	-	-	+
Liang, 2023 (55)	+	+	+	+	+	+
Liu, 2025 (54)	-	-	+	x	x	-
Lu, 2015 (42)	-	-	-	x	x	-
Nam, 2018 (56)	+	+	+	-	-	+
Papavasileiou, 2015 (63)	+	+	-	-	-	+
Ramirez Moreno, 2018 (51)	+	+	-	-	-	+
Smith, 2015 (44)	-	+	-	-	-	-
Song, 2022 (45)	+	+	+	-	-	+
Tsai, 2022 (62)	+	+	+	+	+	+
Tu, 2017 (64)	-	-	-	x	x	-
Wang, 2025 (52)	+	+	+	-	-	+
Westendorp, 2018 (58)	+	+	+	+	+	+
Yan, 2022 (59)	+	+	+	-	-	+
Yu, 2022 (49)	+	+	+	-	-	+
Zapata-Arriaza, 2018 (46)	-	+	-	-	-	-
Zhang, 2017 (47)	-	-	+	x	x	-

Legend: x High - Moderate + Low



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Risk-of-bias assessment and meta-analysis of biomarkers in SAP risk prediction in external validation

Components of risk scores for predicting SAP

Study	Primary Biomarker(s)	PROBAST Domains (Modified for Biomarkers)				Overall Risk of Bias	Applicability
		Participants	Biomarker Measurement	Outcome	Analysis		
Cao, 2021 (83)	Neutrophil count	+	+	+	-	-	+
Chen, 2023 (35)	NLR, CRP, Neutrophil, Lymphocyte, Monocyte, Leukocyte	+	+	+	+	+	+
Gens, 2021 (87)	NLR	+	+	+	-	-	+
Hasse, 2022 (79)	Clinical markers, IL-6, LBP	+	+	+	+	+	+
Hoffman, 2017 (77)	IL-6	-	+	+	-	-	-
Huang, 2022 (50)	CRP, Albumin	+	+	+	+	+	+
Kochetov, 2022 (70)	CRP, IL-6	+	+	+	-	-	+
Li, 2023 (85)	NLR, PLR, MLR	+	+	+	+	+	+
Liang, 2023 (55)	NLR	+	+	+	+	+	+
Lu, 2015 (42)	CRP, Iron, PCT, Ferritin	-	-	-	X	X	-
Nam, 2018 (56)	NLR, CRP, Neutrophil, Lymphocyte	+	+	+	-	-	+
Wang, 2021 (88)	NLR	+	+	+	-	-	+
Wang, 2023 (91)	NLR, PLR	+	+	+	+	+	+
Warusevitane, 2016 (34)	CRP	-	+	-	-	-	-
Wu, 2021 (74)	NLR, CRP, Neutrophil	+	+	+	-	-	+

Legend: X High - Moderate + Low

Predictive performance in external validation

Biomarker	Number of studies	ROC	SE	95% CI	Q	I2	Egger's test
NLR	8	0.803	0.025	0.75 to 0.85	80.11	91.3%	0.018
CRP	7	0.800	0.029	0.74 to 0.86	67.18	91.1%	0.270
Il-6	4	0.808	0.033	0.74 to 0.87	8.24	63.6%	0.157
Neutro-philes	4	0.787	0.033	0.72 to 0.85	39.84	92.5%	0.003

CI – Confidence Interval; Q – Cochran's Q; I^2 – I-squared. CRP – C-Reactive Protein; I^2 – I-squared; IL-6 – Interleukin-6; NLR – Neutrophil-to-Lymphocyte Ratio; Q – Cochran's Q; ROC – Receiver Operating Characteristic; SE – Standard Error.

- Biomarkers show moderate and comparable performance
- High heterogeneity limits generalisability
- Evidence of publication bias for NLR and neutrophils

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Expert Consensus Statement (Prediction)

Scores and biomarkers

Expert consensus statement

We suggest using validated clinical prediction scores or biomarkers to identify patients at increased risk of SAP and to better target preventive standard measures. However, their clinical utility is currently limited by only moderate to good discriminatory performance and is likely to depend on the availability of more effective preventive treatment strategies.

Voting: 8/8

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Evidence-based Recommendations (Prevention)

Preventive antibiotic treatment of SAP

PICO 6 In hospitalised adults with acute ischaemic or haemorrhagic stroke (non-ventilated) within 7 days of stroke symptom onset, does preventive antibiotic treatment compared to no preventive antibiotic treatment reduce SAP frequency and improve clinical outcomes?

Evidence-based Recommendations	Quality of evidence	Strength
In hospitalized, non-ventilated adults with acute ischaemic or haemorrhagic stroke within 7 days of symptom onset, we suggest not using preventive antibiotic therapy, as it has not been shown to reduce the incidence of SAP.	⊕⊕	↓?
In hospitalized, non-ventilated adults with acute ischaemic or haemorrhagic stroke within 7 days of symptom onset, we recommend not using preventive antibiotic therapy, as it has not been shown to improve clinical outcomes.	⊕⊕⊕	↓?

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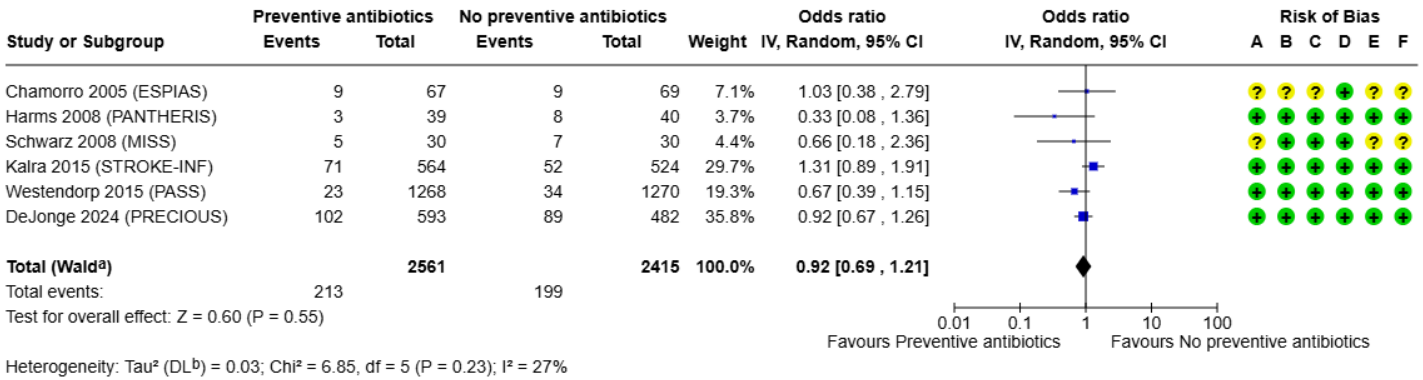
Forest plot and risk-of-bias assessment of studies investigating preventive antibiotic therapy for SAP

SAP incidence (physician-diagnosed)

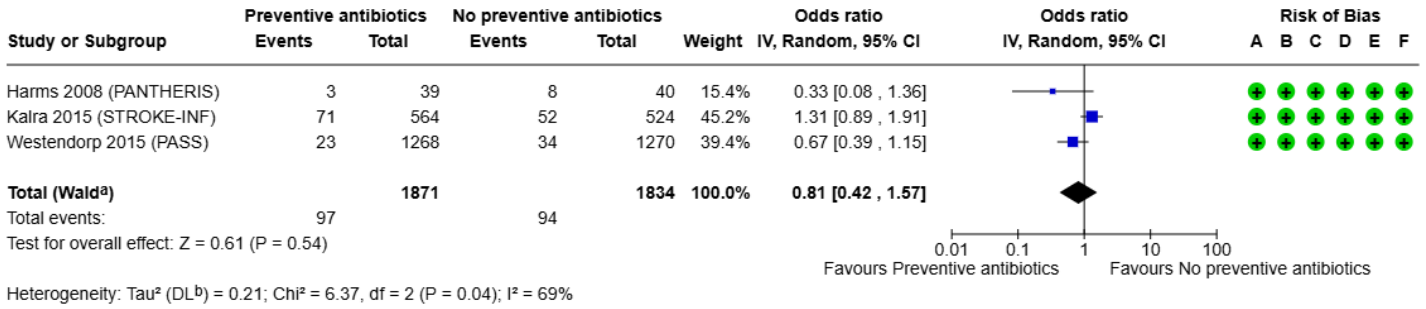


Study or Subgroup	Preventive antibiotics Events	Total	No preventive antibiotics Events	Total	Weight	Odds ratio IV, Random, 95% CI
Chamorro 2005 (ESPIAS)	9	67	9	69	7.1%	1.03 [0.38 , 2.79]
Harms 2008 (PANTHERIS)	3	39	8	40	3.7%	0.33 [0.08 , 1.36]
Schwarz 2008 (MISS)	5	30	7	30	4.4%	0.66 [0.18 , 2.36]
Kalra 2015 (STROKE-INF)	71	564	52	524	29.7%	1.31 [0.89 , 1.91]
Westendorp 2015 (PASS)	23	1268	34	1270	19.3%	0.67 [0.39 , 1.15]
DeJonge 2024 (PRECIOUS)	102	593	89	482	35.8%	0.92 [0.67 , 1.26]
Total (Wald[a])		**2561**		**2415**	**100.0%**	**0.92 [0.69 , 1.21]**
Total events:	213		199			

Test for overall effect: Z = 0.60 (P = 0.55)

Heterogeneity: Tau² (DL[b]) = 0.03; Chi² = 6.85, df = 5 (P = 0.23); I² = 27%

SAP incidence (expert panel-diagnosed)



Study or Subgroup	Preventive antibiotics Events	Total	No preventive antibiotics Events	Total	Weight	Odds ratio IV, Random, 95% CI
Harms 2008 (PANTHERIS)	3	39	8	40	15.4%	0.33 [0.08 , 1.36]
Kalra 2015 (STROKE-INF)	71	564	52	524	45.2%	1.31 [0.89 , 1.91]
Westendorp 2015 (PASS)	23	1268	34	1270	39.4%	0.67 [0.39 , 1.15]
Total (Wald[a])		**1871**		**1834**	**100.0%**	**0.81 [0.42 , 1.57]**
Total events:	97		94			

Test for overall effect: Z = 0.61 (P = 0.54)

Heterogeneity: Tau² (DL[b]) = 0.21; Chi² = 6.37, df = 2 (P = 0.04); I² = 69%

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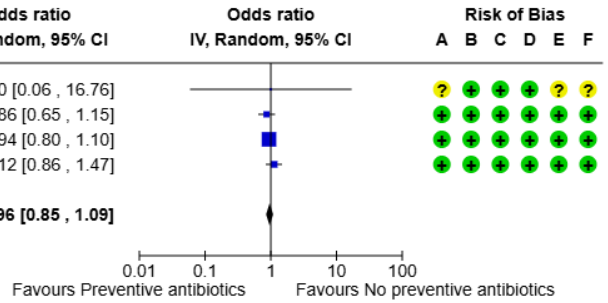
Forest plot and risk-of-bias assessment of preventive antibiotic therapy for outcome

Favourable functional neurological outcome (mRS 0-2) at 90 days

Study or Subgroup	Preventive antibiotics Events	Total	No preventive antibiotics Events	Total	Weight	Odds ratio IV, Random, 95% CI
Schwarz 2008 (MISS)	1	30	1	30	0.2%	1.00 [0.06 , 16.76]
Kalra 2015 (STROKE-INF)	109	595	121	586	18.4%	0.86 [0.65 , 1.15]
Westendorp 2015 (PASS)	487	1268	507	1270	60.3%	0.94 [0.80 , 1.10]
DeJonge 2024 (PRECIOUS)	170	593	127	482	21.1%	1.12 [0.86 , 1.47]
Total (Wald[a])		**2486**		**2368**	**100.0%**	**0.96 [0.85 , 1.09]**
Total events:	767		756			

Test for overall effect: Z = 0.65 (P = 0.51)

Heterogeneity: Tau² (DL[b]) = 0.00; Chi² = 1.92, df = 3 (P = 0.59); I² = 0%

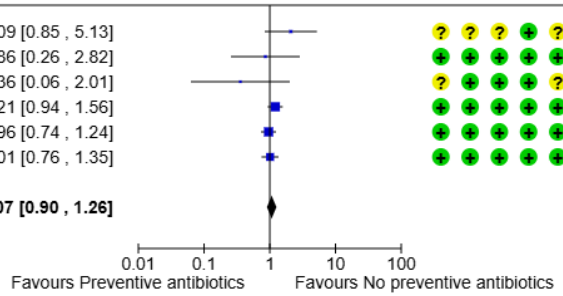


All-cause mortality at 90 days

Study or Subgroup	Preventive antibiotics Events	Total	No preventive antibiotics Events	Total	Weight	Odds ratio IV, Random, 95% CI
Chamorro 2005 (ESPIAS)	16	67	9	69	3.4%	2.09 [0.85 , 5.13]
Harms 2008 (PANTHERIS)	6	39	7	40	1.9%	0.86 [0.26 , 2.82]
Schwarz 2008 (MISS)	2	30	5	30	0.9%	0.36 [0.06 , 2.01]
Kalra 2015 (STROKE-INF)	184	595	158	586	33.5%	1.21 [0.94 , 1.56]
Westendorp 2015 (PASS)	131	1257	136	1257	33.1%	0.96 [0.74 , 1.24]
DeJonge 2024 (PRECIOUS)	134	593	108	482	27.2%	1.01 [0.76 , 1.35]
Total (Wald[a])		**2581**		**2464**	**100.0%**	**1.07 [0.90 , 1.26]**
Total events:	473		423			

Test for overall effect: Z = 0.77 (P = 0.44)

Heterogeneity: Tau² (DL[b]) = 0.01; Chi² = 5.64, df = 5 (P = 0.34); I² = 11%



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Forest plot and risk-of-bias assessment of preventive antibiotic therapy for outcome

- Large trials show no benefit of preventive antibiotic therapy (PAT) for outcome
- However, large trials do not necessarily provide high-certainty evidence (GRADE)
- Overall evidence remains insufficient for a high-certainty recommendation against routine PAT
- Moderate-certainty only for functional outcome (mRS 0 – 2)
- Clinically relevant residual uncertainty persist
- Further trials should incorporate clinical risk scores and biomarkers to identifying patients at high risk for SAP

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Evidence-based Recommendations (Prevention)

Drugs to prevent SAP – antiemetics, ß-blockers, statins…

PICO 7 In hospitalised adults with acute ischaemic or haemorrhagic stroke (non-ventilated) within 7 days of stroke symptom onset, does usage of specific drugs (e.g. antiemetics, beta-blockers, statins, acid-suppressing medication) compared to no usage of these specific drugs affect SAP frequency and clinical outcomes?

Evidence-based Recommendations	Quality of evidence	Strength
In hospitalized, non-ventilated adults with acute ischaemic or haemorrhagic stroke within 7 days of symptom onset, there is currently insufficient evidence to make an evidence-based recommendation regarding the use of antiemetics for the prevention of SAP. Please see the Expert Consensus Statement below.	-	-

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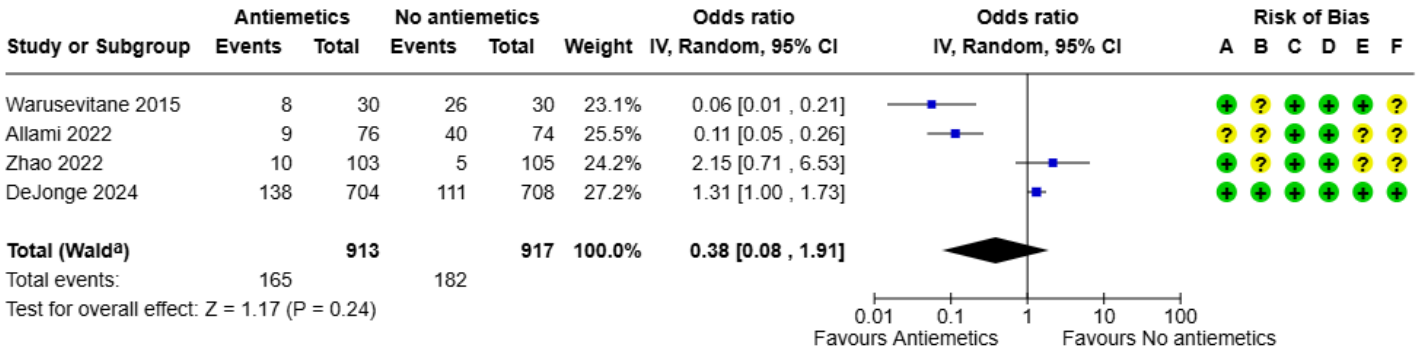
Forest plot and risk-of-bias assessment of studies investigating antiemetics of prevention for SAP

SAP incidence

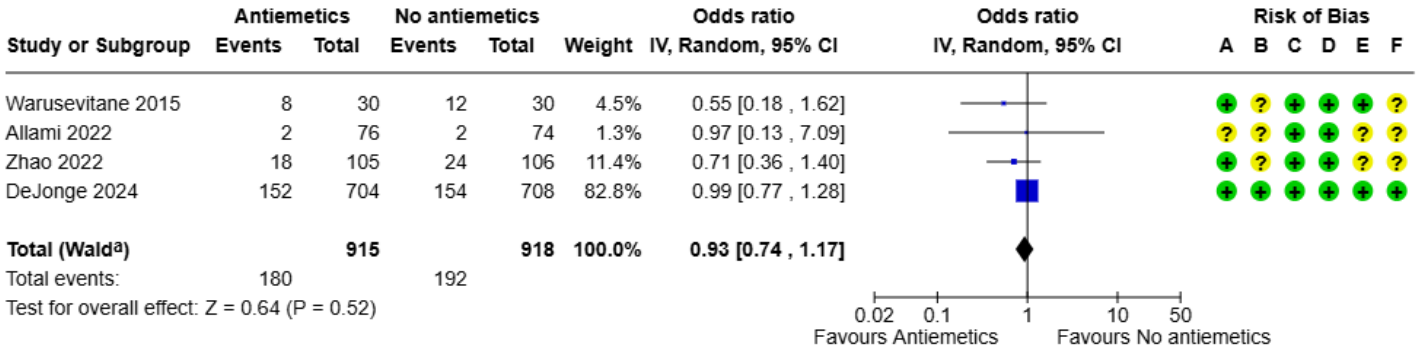


Study or Subgroup	Antiemetics Events	Antiemetics Total	No antiemetics Events	No antiemetics Total	Weight	Odds ratio IV, Random, 95% CI
Warusevitane 2015	8	30	26	30	23.1%	0.06 [0.01 , 0.21]
Allami 2022	9	76	40	74	25.5%	0.11 [0.05 , 0.26]
Zhao 2022	10	103	5	105	24.2%	2.15 [0.71 , 6.53]
DeJonge 2024	138	704	111	708	27.2%	1.31 [1.00 , 1.73]
Total (Wald[a])		**913**		**917**	**100.0%**	**0.38 [0.08 , 1.91]**
Total events:	165		182			

Test for overall effect: Z = 1.17 (P = 0.24)

Heterogeneity: Tau² (DL[b]) = 2.45; Chi² = 49.69, df = 3 (P < 0.00001); I² = 94%

All-cause mortality at 90 days



Study or Subgroup	Antiemetics Events	Antiemetics Total	No antiemetics Events	No antiemetics Total	Weight	Odds ratio IV, Random, 95% CI
Warusevitane 2015	8	30	12	30	4.5%	0.55 [0.18 , 1.62]
Allami 2022	2	76	2	74	1.3%	0.97 [0.13 , 7.09]
Zhao 2022	18	105	24	106	11.4%	0.71 [0.36 , 1.40]
DeJonge 2024	152	704	154	708	82.8%	0.99 [0.77 , 1.28]
Total (Wald[a])		**915**		**918**	**100.0%**	**0.93 [0.74 , 1.17]**
Total events:	180		192			

Test for overall effect: Z = 0.64 (P = 0.52)

Heterogeneity: Tau² (DL[b]) = 0.00; Chi² = 1.78, df = 3 (P = 0.62); I² = 0%

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Expert Consensus Statement (Prevention)

Antiemetics for prevention of SAP?

Expert consensus statement

We suggest not to administer antiemetics for the prevention of SAP hospitalized, non-ventilated adults with acute ischaemic or haemorrhagic stroke within 7 days of symptom onset outside of clinical trials, as there is insufficient evidence for this indication. However, we suggest using these drugs for the treatment of nausea and vomiting, guided by local guidelines and clinical judgement. A large phase 3 randomised controlled trial investigating metoclopramide for preventing SAP in the first two weeks after stroke is currently ongoing.

Voting: 8/8

Evidence-based Recommendations (Prevention)

Drugs to prevent SAP – antiemetics, ß-blockers, statins…

PICO 7 In hospitalised adults with acute ischaemic or haemorrhagic stroke (non-ventilated) within 7 days of stroke symptom onset, does usage of specific drugs (e.g. antiemetics, beta-blockers, statins, acid-suppressing medication) compared to no usage of these specific drugs affect SAP frequency and clinical outcomes?

Evidence-based Recommendations	Quality of evidence	Strength
In hospitalized, non-ventilated adults with acute ischaemic or hemorrhagic stroke within 7 days of symptom onset, there is no evidence from RCTs or observational studies to determine whether starting beta-blockers after stroke prevents pneumonia. We are therefore unable to make an evidence-based recommendation. Please see the Expert Consensus Statement below.	-	-

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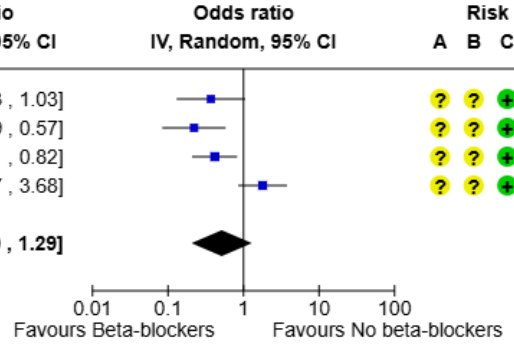
Forest plot and risk-of-bias assessment of studies investigating beta-blockers of prevention for SAP

SAP incidence

Study or Subgroup	Beta-blockers Events	Beta-blockers Total	No beta-blockers Events	No beta-blockers Total	Weight	Odds ratio IV, Random, 95% CI
Dziedzic 2007	4	88	85	745	22.7%	0.37 [0.13 , 1.03]
Kalita 2013	7	79	18	59	23.7%	0.22 [0.09 , 0.57]
Sykora 2015	9	244	418	4968	27.1%	0.42 [0.21 , 0.82]
Starr 2017	21	424	12	424	26.5%	1.79 [0.87 , 3.68]
Total (Wald[a])		**835**		**6196**	**100.0%**	**0.51 [0.20 , 1.29]**
Total events:	41		533			

Test for overall effect: Z = 1.42 (P = 0.16)

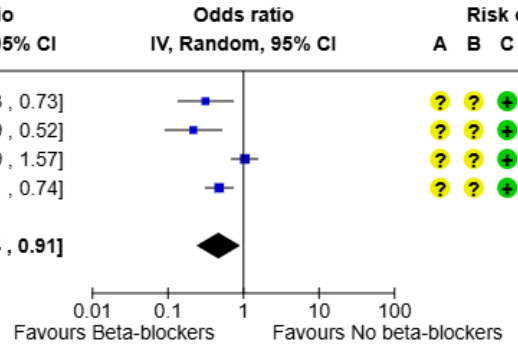


Heterogeneity: Tau² (DL[b]) = 0.70; Chi² = 14.91, df = 3 (P = 0.002); I² = 80%

All-cause mortality at 90 days

Study or Subgroup	Beta-blockers Events	Beta-blockers Total	No beta-blockers Events	No beta-blockers Total	Weight	Odds ratio IV, Random, 95% CI
Dziedzic 2007	6	88	141	745	21.4%	0.31 [0.13 , 0.73]
Kalita 2013	9	79	22	59	21.0%	0.22 [0.09 , 0.52]
Starr 2017	54	424	52	424	29.0%	1.04 [0.69 , 1.57]
Sykora 2015	23	244	891	4968	28.6%	0.48 [0.31 , 0.74]
Total (Wald[a])		**835**		**6196**	**100.0%**	**0.46 [0.24 , 0.91]**
Total events:	92		1106			

Test for overall effect: Z = 2.25 (P = 0.02)



Heterogeneity: Tau² (DL[b]) = 0.36; Chi² = 15.70, df = 3 (P = 0.001); I² = 81%

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Expert Consensus Statement (Prevention)

Beta-blockers for prevention of SAP?

Expert consensus statement

In hospitalised, non-ventilated adults with acute ischaemic or haemorrhagic stroke within 7 days of symptom onset, we suggest not to initiate beta-blockers for the prevention of SAP. However, if patients are taking beta-blockers for other reasons after the stroke, these should be continued, as there is no reason to stop them and weak evidence for a reduction in mortality.

Voting: 8/8

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Evidence-based Recommendations (Prevention)

Early mobilisation to prevent SAP

PICO 10 In hospitalised adults with acute ischaemic or haemorrhagic stroke (non-ventilated) within 7 days of stroke symptom onset, do early physical treatments to address mobility, compared to no early physical treatments to address mobility, reduce SAP frequency and improve clinical outcomes?

Evidence-based Recommendations	Quality of evidence	Strength
In hospitalized, non-ventilated adults with acute ischaemic or haemorrhagic stroke within 7 days of symptom onset, we suggest that physical interventions to promote mobilization, either within bed or out of bed, should be initiated early (within 48 hours) to prevent SAP. Please see the Expert Consensus Statement below.	⊕	↑?

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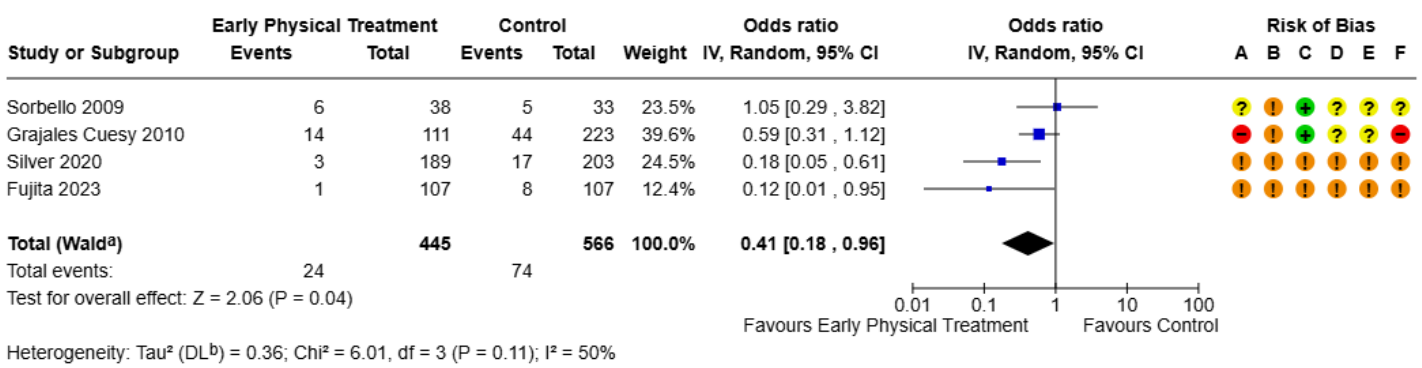
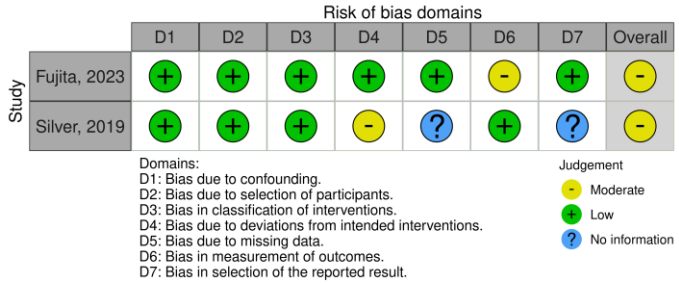
Forest plot and risk-of-bias assessment of studies investigating early mobilisation for SAP prevention

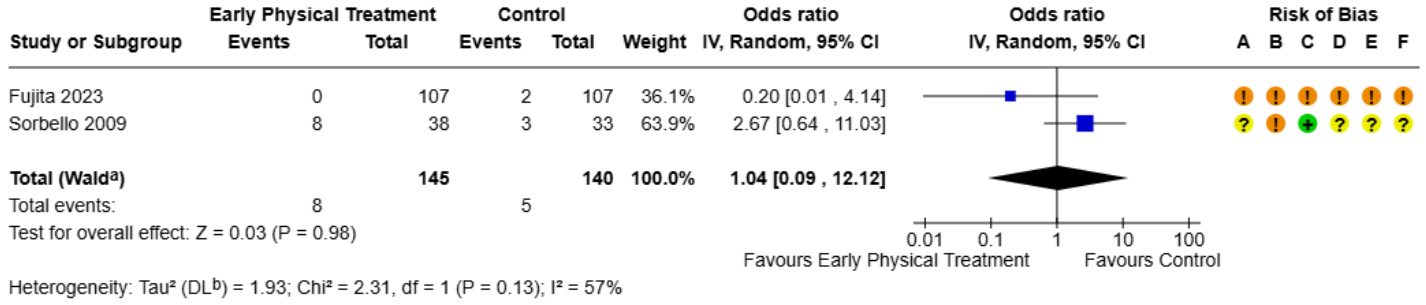
SAP incidence





ROBINS-I risk of bias profile for non-randomised studies

All-cause mortality at 90 days



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Expert Consensus Statement (Prediction)

Early mobilisation to prevent SAP

Expert consensus statement

In hospitalised, non-ventilated adults with acute ischaemic or haemorrhagic stroke within 7 days of symptom onset, we therefore suggest to mobilise within the 48 hour window for the prevention of SAP. However, based on the results of the AVERT study very early (within less than 24 h of onset) and prolonged mobilisation out of bed should be avoided in patients with severe strokes, as it is associated with worse outcomes in that group.

Voting: 8/8

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Key recommendations and suggestions of the Guideline

In patients hospitalised, non-ventilated adults with acute ischaemic or haemorrhagic stroke within 7d of symptom onset

1. Use a standardised algorithm-based approach for SAP diagnosis
2. Consider using validated clinical prediction scores or biomarkers to identify patients at increased risk of SAP, to better target preventive standard measures.
3. Do not use preventive antibiotic therapy, as it does not reduce SAP incidence or improve clinical outcomes. Initiate antibiotic therapy promptly upon confirmed diagnosis of SAP.
4. Do not use metoclopramide, statins, beta-blockers, ACE inhibitors/angiotensin receptor blockers, acid-suppressive drugs (PPIs or H_2-receptor antagonists), antacids, or benzodiazepines for the prevention of SAP. Continue or initiate statins or beta-blockers these drugs if indicated for other conditions before or after stroke.
5. Use the feeding method with which the clinical team is most familiar if nasogastric feeding is required, without preference for intermittent or continuous enteral feeding.
6. Consider respiratory physiotherapy as part of an early post-stroke rehabilitation programme to improve respiratory function and potentially reduce respiratory complications.
7. Initiate mobilisation (in or out of bed) within 48 hours of symptom onset to prevent SAP but avoid very early (<24 hours) and prolonged out-of-bed mobilisation in patients with severe stroke.
8. Treat SAP with empirical antibiotic therapy as early as possible after clinical diagnosis, ideally within a few hours, and perform routine microbiological diagnostics prior to initiation where feasible.
9. Treat SAP with empirical antibiotic therapy according to local or regional protocols, primarily following aspiration pneumonia recommendations and targeting aerobic Gram-negative bacilli and Gram-positive cocci, including Pseudomonas coverage where relevant risk factors are present.
10. Determine the duration of antibiotic treatment on clinical response and treat for at least five days.

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Areas of future research

Diagnosis

- Establish validated, standardised criteria

Prediction

- Establish practical and highly predictive risk scores and biomarkers for early identification of high-risk patients in clinical practice

Prevention

- Establish highly effective targeted prevention strategies for SAP
- Prioritize dedicated clinical trials in well-defined high-risk populations

Treatment

- Define optimal antibiotic choice and timing
- Develop targeted, mechanism-based therapies such as immunomodulatory interventions

Prognosis

- Assess impact of decision-making (e.g. EoL) and care pathways
- Assess impact of effective measures to prevent SAP on neurological outcome

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Conclusion

- Provides pragmatic, evidence-informed guidance for the management of SAP
- The available evidence is predominantly of low quality → many recommendations are based on expert consensus
- Substantial evidence gaps remain in diagnosis, risk prediction, prevention, and treatment
- High-quality studies and RCTs are urgently needed
- Future research should prioritize targeted strategies incorporating risk scores and biomarkers

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