Non-Ventilator Hospital Acquired Pneumonia

Webber Infection Control Seminars
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- **Grant funding**
  - Centers for Disease Control and Prevention
  - Massachusetts Department of Public Health
  - Agency for Healthcare Research and Quality
- **Royalties**
  - UpToDate Inc.

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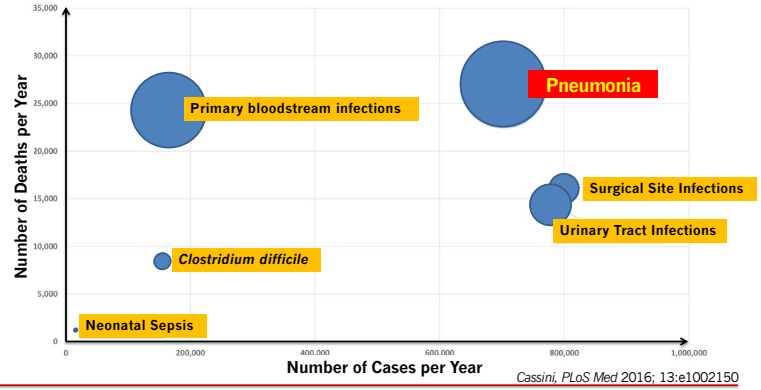
Burden & Mortality of HAIs in Europe



Cassini, PLoS Med 2016; 13:e1002150

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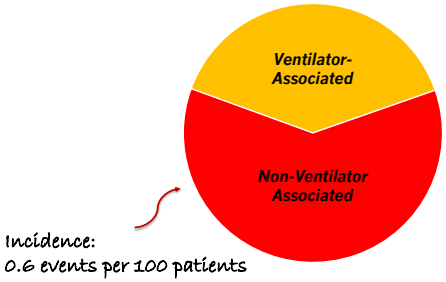
Most Nosocomial Pneumonias Affect Non-Ventilated Patients

CDC one day point-prevalence survey of healthcare-associated infections, 199 hospitals, 10 U.S. states



Magill, *N Engl J Med* 2018;379:1732-1744

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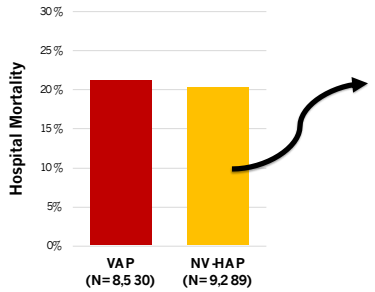
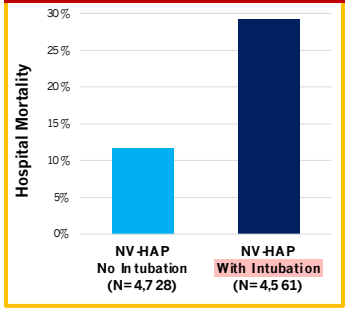
NV-HAP Mortality: As Bad as VAP

Retrospective analysis of 17,819 patients with HAP in 253 US hospitals, 2012-2019

NV-HAP Mortality as Bad as VAP…



…or Worse than VAP



Zilberberg, *Crit Care Med* 2022;50:460-468

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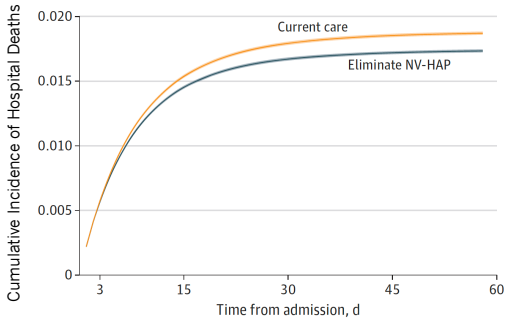
What if we could eliminate NV-HAP?

Analysis of 6.02 million admissions to 284 US hospitals. Modeled impact of eliminating NV-HAP, adjusting for hospital factors and patients' demographics, comorbidities, service, daily vital signs, & daily laboratory test results



Eliminating NV-HAP would reduce overall hospital mortality by ~7.3%

Jones, *JAMA Network Open* 2023;6(5):e2314185

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NV-HAP: Two Critical Challenges

How should we track NV-HAP?

How can we prevent NV-HAP?

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How should we track NV-HAP?

ICD10 codes?

Chart Reviews?

CDC Criteria?

Antibiotic Starts?

9

The Challenge of NV-HAP Diagnosis & Surveillance

Imaging	*Systemic Signs*	*Pulmonary Signs*
New or progressive and persistent Infiltrate or Consolidation or Cavitation	Fever >38.0°C WBC <4K or >12K Altered mental status	New onset purulent sputum, change in character of sputum, increased secretions New onset or worsening cough, dyspnea, or tachypnea Rales of bronchial breath sounds Worsening gas exchange, increased oxygen requirement

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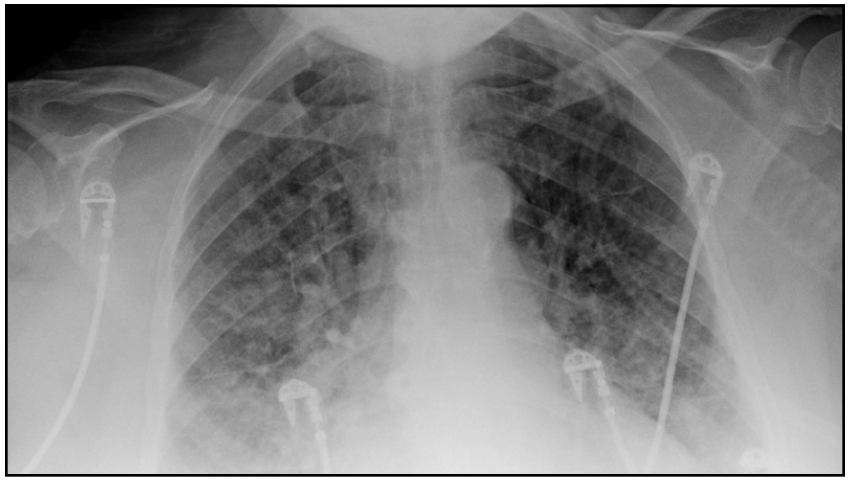

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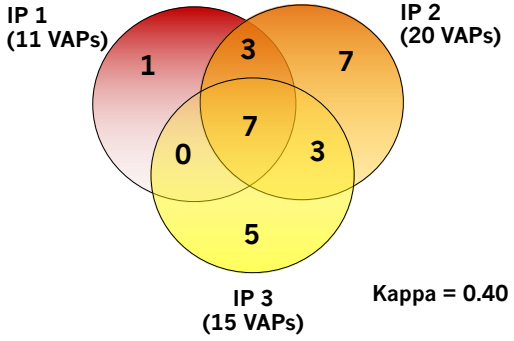
Interobserver Agreement on PNEU Definitions

50 ventilated patients with respiratory deterioration



Kappa = 0.40

Am J Infect Control 2010:38:237

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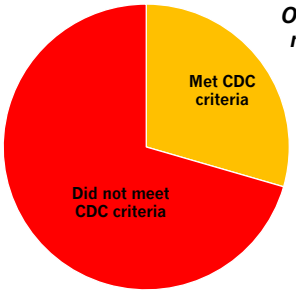
Accuracy of Diagnosis Codes

4,451 patients with pneumonia diagnosis codes, not present-on-admission, 21 hospitals


American Journal of Infection Control

Hospital Acquired Pneumonia Prevention Initiative-2: Incidence of nonventilator hospital-acquired pneumonia in the United States

Dian Baker PhD, RN [1], Barbara Quinn MS, RN [2]



Only 30% of cases met CDC criteria for pneumonia!

Baker, *Am J Infection Control* 2018;46:2-7

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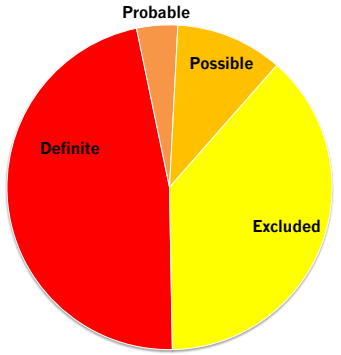
Accuracy of Clinical Diagnosis

319 consecutive patients with clinically suspected pneumonia sent for CT

Final Pneumonia Classification After CT:



~50% of clinically-diagnosed pneumonias excluded or unlikely!

Claessens, *AJRCCM* 2015;192:974-982

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Clinical Signs in Patients Started on Antibiotics for HAP

2,733 patients admitted to 4 Boston hospitals & started on antibiotics for pneumonia on day ≥3, 2015-2018

71% had a temperature >36° and <38° C

80% had a median respiratory rate <22 breaths/min

49% had a WBC count >4,000 and <12,000 cells/mm^3

35% had O_2 sat > 95% on ambient air

Klompas, *JAMA Network Open* 2020;3(7):e2010700

Resp rate and O2 sat normal in 32% !!!

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Alternatives

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NV-HAP Electronic Surveillance Definition

Worsening Oxygenation	+	Fever or Leukocytosis	+	Performance of Chest Imaging	+	≥3 days of New Antibiotics
Drop in SpO2 to <95% on room air, initiation of supplemental oxygen, or escalation of supplemental oxygen		*WBC <4 or >12 or Temp <36° or >38° C*		*Chest X-ray or CT Scan*		*New = not given in previous 2 days; can be different antibiotics for each day so long as each one is new*

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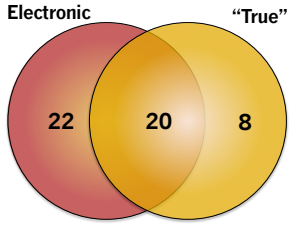
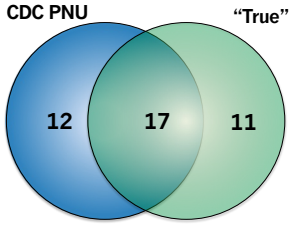
Correlation with "True" Pneumonia per Reviewer

Chart review exercise to assess correlation between the electronic NV-HAP surveillance definition vs "truth" (N=120)



sensitivity 71%
positive predictive value 48%
kappa 0.40



sensitivity 61%
positive predictive value 59%
kappa 0.47

Ramirez Batlle, *ICHE* 2020;41:219-221

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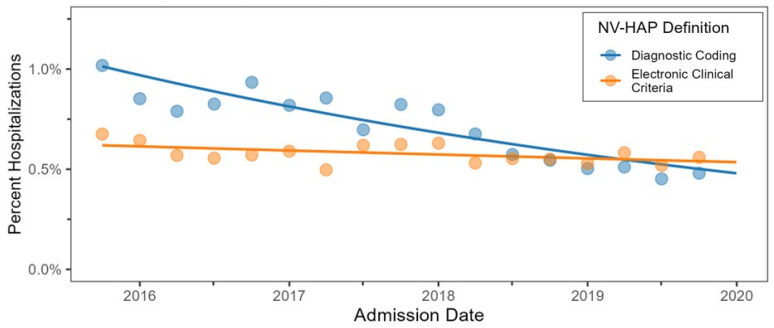
NV-HAP Trends with Codes vs Electronic Clinical Criteria

Trends in NV-HAP rates detected with diagnosis codes vs electronic clinical criteria, 17 VA hospitals, 2015-2019



Jones, *Infection Control & Hospital Epidemiology* 2025, in press

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Semi-automated surveillance for NV-HAP

University of Zurich, cohort of 157,902 patients, 947 with NV-HAP

- Electronically screen patients for indicators of possible NV-HAP
  - Hospital length of stay >5 days
  - Temperature >38° C
  - WBC count <4 or ≥12
  - CRP ≥ 20mg/ml
  - Impaired oxygenation
  - Antimicrobial use
  - Free text parsing of chest imaging reports to exclude patients without pneumonia
- Manual chart review to confirm or rule out pneumonia

Flagged 6,205 patients. Confirmed NV-HAP in 867.

Sensitivity: 92% ***Workload Reduction: 96%*** ***Number Needed to Screen: 6.4***

Mueller, *Clin Micro Infection* 2025;31:582-587

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A Case for Your Consideration

- A 67-year-old woman with a history of heart failure is admitted following first-onset seizure. Intubated for airway protection and treated with anticonvulsants.
- Head imaging is concerning for tumor. Brain biopsy confirms high-grade glioma.
- She is extubated 3 days after surgery but has agitated delirium. Treated with dexmedetomidine. A nasogastric tube is placed for enteral feeding.
- One week later she develops increased fever, leukocytosis, and increased oxygen requirement. CXR with bilateral patchy infiltrates.
- Vancomycin and cefepime are started. Sputum culture grows *Staph aureus*.
- Fever and leukocytosis improve. Delirium and oxygen requirement persist. She has progressive obtundation.
- Repeat head imaging shows progression of glioblastoma.
- She is too unstable for cancer treatment. Family elects to transition to comfort care only. She passes away two days later.

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Was this pneumonia preventable?

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Was this death preventable?

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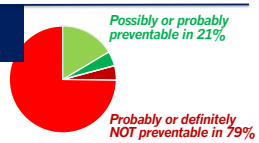
Preventability of NV-HAP Deaths

Systematic review of 150 patients who died in one of 4 Mass General Brigham hospitals following an NV-HAP event. Two ID docs reviewed each case to estimate the preventability of NV-HAP and death.

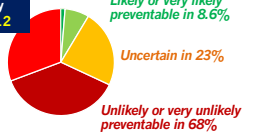
Very Sick Population at Baseline

- Median age 69
- Comorbidities common
  - 57% cancer
  - 30% chronic kidney disease
  - 29% chronic lung disease
  - 27% heart failure
- Challenging risk factors common
  - 76% altered mental status
  - 35% dysphagia
  - 27% orogastric/nasogastric tubes
- 54% with hospice qualifying conditions before NV-HAP
- 24% with care limitations before developing NV-HAP

NV-HAP
Possibly or Probably Preventable in 1 of 5



Death
Likely or Very Likely Preventable in 1 of 12



Tatara, *Clin Infect Dis* 2024;79:1269-1276

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Infection Control & Hospital Epidemiology (2022), 1–27
doi:10.1017/ice.2022.88

SHEA

SHEA/IDSA/APIC Practice Recommendation

Strategies to prevent ventilator-associated pneumonia, ventilator-associated events, and nonventilator hospital-acquired pneumonia in acute-care hospitals: 2022 Update

Michael Klompas MD, MPH[1,2], Richard Branson MSc, RRT[3], Kelly Cawcutt MD, MS[4], Matthew Crist MD[5], Eric C. Eichenwald MD[6,7], Linda R. Greene RN, MPS, CIC[8], Grace Lee MD[9], Lisa L. Maragakis MD, MPH[10], Krista Powell MD, MPH[5], Gregory P. Priebe MD[11], Kathleen Speck MPH[12], Deborah S. Yokoe MD, MPH[13] and Sean M. Berenholtz MD, MHS[12,14,15]

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Compendium Recommendations to Prevent NV-HAP

Interventions that may lower NV-HAP rates

- Provide regular oral care (daily toothbrushing)
- Diagnose and manage dysphagia
- Provide early mobilization
- Implement multimodal interventions to prevent viral infections

Interventions with insufficient data about impact on NV-HAP

- Head of bed elevation
- Stress ulcer prophylaxis

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Meta-Analysis: 15 Randomized Trials*

*all but 2 in ventilated patients

	Studies	Patients	Meta-Analysis	
Hospital-acquired pneumonia* *12 of the 14 studies in ventilated patients	14	2557	**Risk Ratio 0.68 (95% CI 0.57-0.82)**	***Lower!***
Ventilator Days	7	1285	**-1.2 days (95% CI -2.4 to -0.1)**	***Lower!***
ICU Length of Stay	6	1284	**-1.8 days (95% CI -2.9 to -0.7)**	***Lower!***
ICU Mortality	6	1331	**Risk Ratio 0.81 (95% CI 0.69-0.95)**	***Lower!***

Ehrenzeller, *JAMA Internal Med* 2024;184(2):131-142

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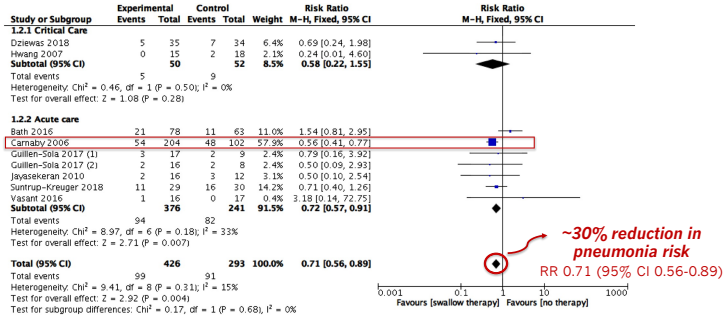
Impact of Dysphagia Management on Pneumonia

Meta-analysis of 8 randomized & quasi-randomized trial of dysphagia management for patients with acute stroke



Duncan, *Intensive Care Med* 2020; 46:1326–1338

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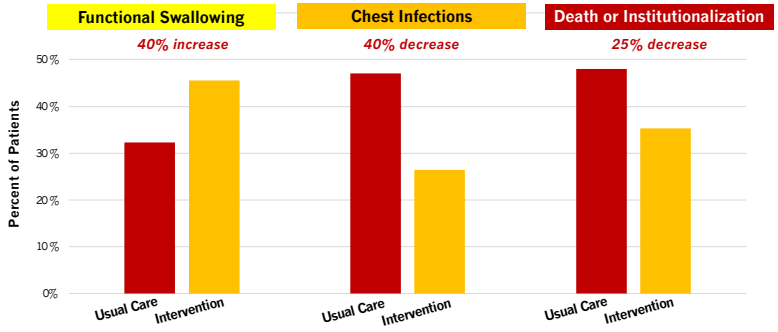
Dysphagia Management in Acute Stroke

306 patients with acute stroke randomized to upright position for feeding, safe swallowing advice (e.g. reduced rate of eating, effortful swallowing), and dietary modification under guidance of a speech pathologist at least 3x/week x 4 weeks



Carnaby, *Lancet Neurol* 2006; 5: 31–37

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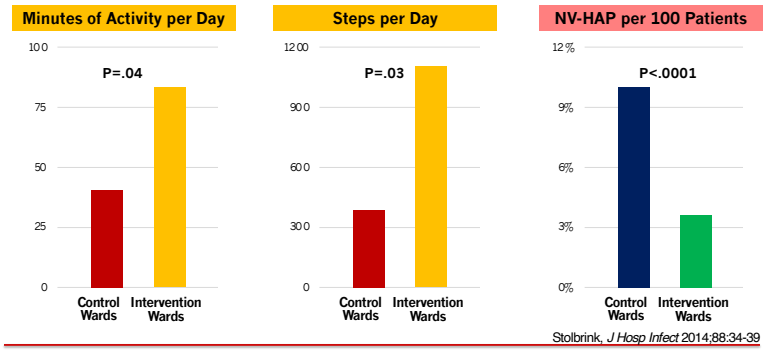
Controlled Trial of Early Mobility on NV-HAP

Mobility bundle implemented in an elderly care & respiratory care ward in one hospital. Activity levels and patient outcomes compared to patients receiving usual care in 2 similar wards in a sister hospital.



Stolbrink, *J Hosp Infect* 2014;88:34-39

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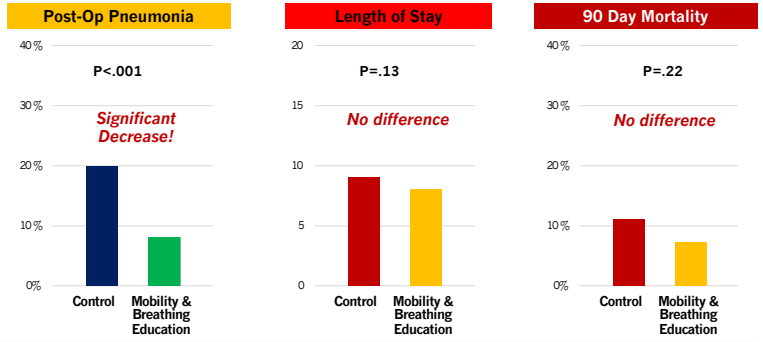
Pre-Operative Mobility & Breathing Education

441 adults with upper abdominal surgery randomized to pre-op physiotherapy session (education about pulmonary complications of surgery, the importance of ambulation, and breathing exercises) vs information booklet alone



Boden, *BMJ* 2018;360:j5916

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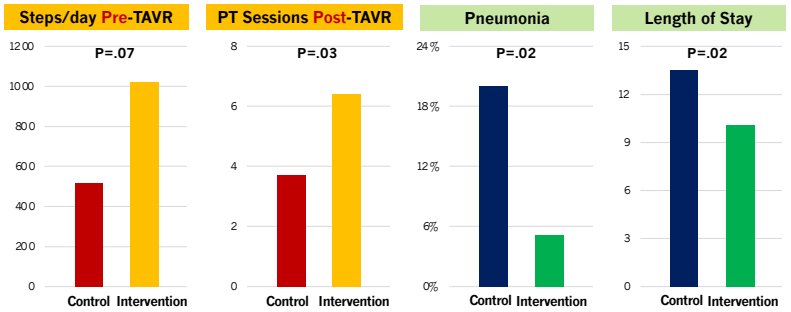
Intensified Physiotherapy Pre- and Post- TAVR

108 patients with aortic stenosis randomized to intensified physiotherapy pre- and post-TAVR
Pre-TAVR: Inspiratory muscle training 5mins x 4/day, walking x 30mins/day vs nothing
Post-TAVR: individualized physiotherapy 30mins/day twice daily vs once daily



Weber, *J Interventional Cardiology* 2021;8894223

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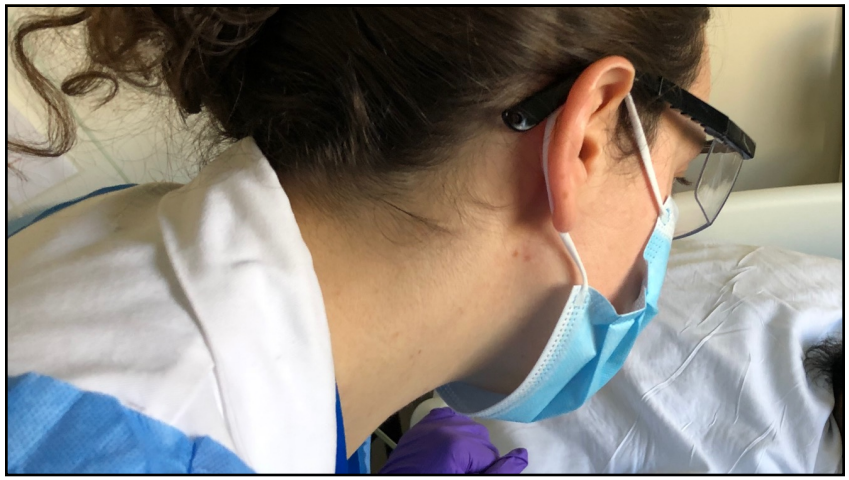

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Viruses Common in HV-HAP

174 Patients with Non-Ventilator HAP
Barnes-Jewish Hospital, St Louis

viruses in
22%
of patients

99 Patients with HAP Admitted to ICU
Bichat-Claude Bernard Hospital, Paris

viruses in
34%
of patients

18% with virus alone
14% with virus + bacteria

Respiratory Medicine 2017;122:76-80

J Clinical Virology 2017;91:52-57

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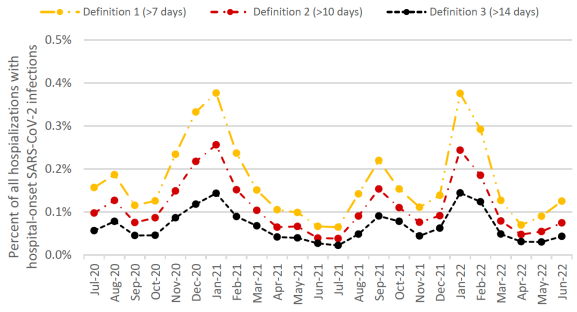
Nosocomial SARS-CoV-2

Retrospective analysis of hospital-onset SARS-CoV-2 cases, 4.4 million hospitalizations, 288 U.S. hospitals



- **Over 14,000 cases**
  - 7591 dx day >7
  - 6455 dx days 4-7
- **Present in 0.4% of hospital admissions**
- **Up to 8.2% of Covid in the hospital acquired in the hospital**
- **Every 10% increase in community incidence of SARS-CoV-2 associated with a 3-fold increase in hospital-onset infections**

Hatfield, *JAMA Network Open* 2023;6(8):e2329441

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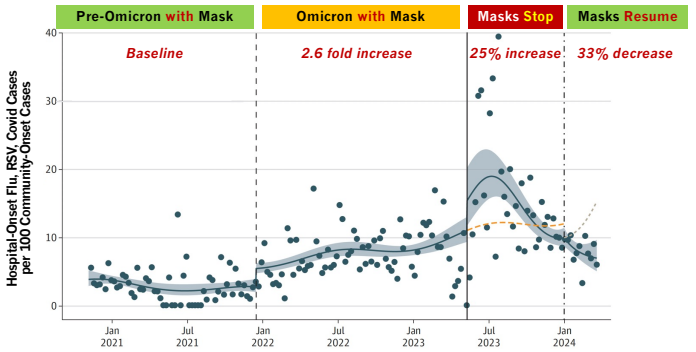
Masking and Hospital-Onset Respiratory Viral Infections

Associations between Masking Policies and Hospital-Onset Influenza, RSV, and Covid in 10 US Hospitals



Pak, *JAMA Network Open* 2024;7(11):e2448063

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NV-HAP Prevention Bundles

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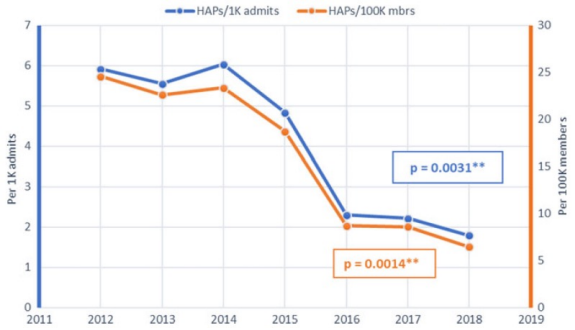
‘ROUTE’ initiative associated with 70% drop in HAP

21 hospitals, Kaiser Northern California, 2012-2019

Respiratory care
Oral care
Up in chair
Tube care
Education



Lacerna, ICHE 2020;41:547-552

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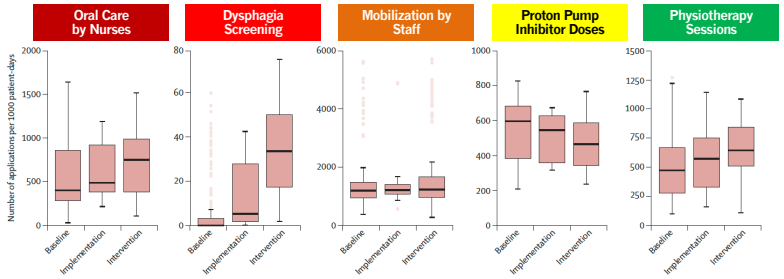
NV-HAP Prevention Bundle

University Hospital Zurich, NV-HAP prevention bundle, 9 surgical and medical wards, Jan 2017-Feb 2020



Wolfensberger, *Lancet Infect Dis* 2023;23:836-846

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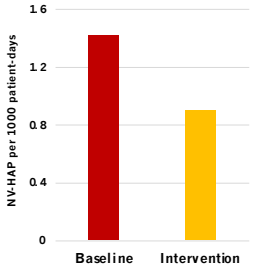
NV-HAP Prevention Bundle

University Hospital Zurich, NV-HAP prevention bundle, 9 surgical and medical wards, Jan 2017-Feb 2020

30% drop in NV-HAP incidence



Factors associated with successful implementation:

- Staff belief that preventing NV-HAP is aligned with their core mission as healthcare workers
- High perceived NV-HAP risk per patient
- Hospital architecture promoting proximity between key staff members
- Favorable staff character traits
  - Positive attitude
  - Charisma
  - Intrinsic motivation
  - Authority & latitude to make decisions

Wolfensberger, *Lancet Infect Dis* 2023;23:836-846

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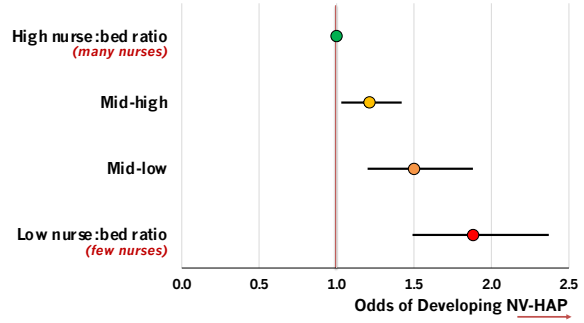
Good NV-HAP Prevention is Nursing Intensive

Association between nurse:bed ratios and NV-HAP Incidence
37,706 surgical patients admitted to ICU, Korean National Insurance Cohort, 2008-2019



Park, *Epidemiology & Infection* 2024;152:e62 (PMID 38326273)

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Summary

- **NV-HAP is common and deadly. Surveillance is challenging.**
- **Recommended to prevent NV-HAP:**
  - Regular oral care (daily toothbrushing)
  - Diagnose and manage dysphagia
  - Provide early mobilization
  - Prevent respiratory viral infections
- **NV-HAP prevention bundles look promising**
- **Larger, more robust studies needed to better define the ideal NV-HAP prevention bundle components and to demonstrate their utility.**

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