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Pathophysiology and **Prevention of Non-Ventilator Hospital Acquired Pneumonia** (NVHAP): A CNS-Sensitive Outcome



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Disclosures

- 2011 Unrestricted research grant for data collection (Sage LLC)
- 2013 Unrestricted research grant for multiple site data collection (Sage LLC)



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Objectives

- 1. Explain the **significance of NV-HAP** for patients and the U.S. healthcare system
- 2. Discuss **pathogenesis & prevention** of NV-HAP
- 3. List **3 essential steps for the CNS** to address and prevent NV-HAP



or m of NVaddress

The Story of May...



May is a 57 year old grandmother who develops nonventilator hospital acquired pneumonia (NV-HAP)

Why does this keep happening?

Emma Winn Healthy Elderly - not a real patient http://www.fhms.surrey.ac.uk/nutritionandbone/swiss.html



The Journey Begins: Is NV-HAP a Problem?

- Previous focus was only on device-related infections* Ventilator Associated Pneumonia (VAP) * from the CDC Point Prevalence Study (2008)
- But how much non-ventilator pneumonia was occurring in the ullethospital?
- Was it happening in other hospitals? ullet
- If so, who was "at-risk"? Was it preventable? How? ullet





Incidence, **Prevalence** of **NV-HAP**: A 3-hospital systems study (2010 data) Kaiser, VA, and Sutter

- Sutter Medical Center (2010): \bullet
 - -24,482 patients;
 - 94,247 patient days
 - 115 NV-HAP
- Total estimated annual effect:
 - \$4.6 million
 - 23 deaths
 - 1035 days





Quinn, B., Baker, D., et. al. (2014). Basic nursing care to prevent nonventilator hospital-acquired pneumonia. Journal of Nursing Scholarship.

National HAPPI-2 Incidence Study (2014 data)

- 21 U.S. Hospitals, 1300 NV-HAP Cases = \$52.5M
- 16% mortality
 - 33% transferred to ICU died
- Non-ICU impact
 - 60% occurred on Med/Surg units
 - 19% transferred to higher level of care
- ICU impact

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- 27% acquired in ICU + 19% transferred to ICU
 =46% of NV-HAP patients spent time in the ICU
- Morbidity / quality of life
 - 40% admitted from home were not discharged back to home or died
 - 19% readmitted within 30 days

Baker & Quinn (2018) American Journal of Infection Control

Study	Incidence/ Cases Associated Mortality (%)		+LOS (Days)	
Davis, J. & Finley E. ECRI Penn Safety Authority (2012)	1,620	18.9%	Not queried	
Davis, J. & Finley E. (2018)	1,380	22.5%	* 6 years later Still a serious patient safety issue	
Magill et al. Point Prevalence Study CDC NEJM 2014, 2018	(2014) PNA 21.8 % of all HAIs (2018) PNA 25%	PNA prevalence increased percentage of HAI cases	* 4 years later Still a serious patient safety issue	
Micek, Chew, Hamptom & Kollef (2016)	174 cases NV-HAP Matched controls equally sick patients	15.5% vs. 1.6% 8.4 X more likely to die	15.9 vs. 4.4 Equally sick acquire NV-HAP vs. Not	





Total cost all cases \$47,462,290 Per case \$29,297

Total cost all cases \$42,259,340 Per case \$30,622

Study	Incidence/ Cases	Associated Mortality (%)	+LOS (Days)
See et al. (2016)	Retrospective review 8 hospitals in PA 2011-2012 VAP excluded 30% of 838 cases reviewed by CDC epidemiologists	30.9%	
Giuliani, Baker, Quinn (2018) 2012 HCUP Database	3.63/1,000 pt/days (overall incidence 1.6%)	14.5%	4
Baker & Quinn, HAPPI- 2 Incidence Study (2018)	Nationwide study 21 hospital sample of 2014 data	16%	7.9
NVHAP Impact on Medicaid Patients (DentaQuest unpublished data)	3.29 % vs. 0.02% VAP	17.9%	6





Note: verified that ICD data was reasonably reliable to monitoring incidence

> \$36,400 \$14.5B total vs. \$1.3B VAP (2012 data) ICU utilization Readmissions

Morbidity

\$43K /case \$1.6B 10% Medicaid dollars

Is Pneumonia Part of the Sepsis Picture?

	Site of infection	Frequency %		Mortality %	
		Male	Female	Male	Female
30-50% of sensis	Respiratory	41.8	35.8	22.0	22.0
cases may	Bacteremia	21.0	20.0	33.5	34.9
initiate with	Genitourinary	10.3	18.0	8.6	7.8
pneumonia	Abdominal	8.6	8.1	9.8	10.6
	Device related	1.2	1.0	9.5	9.5
	Wound/ soft tissue	9.0	7.5	9.4	11.7
	Central nervous system	0.7	0.5	17.3	17.5
	Endocarditis	0.9	0.5	23.8	28.1
	Other/ unspecified	6.7	8.6	7.6	6.5



Objective #1 Summary: Significance

- HAP is the NUMBER ONE HAI in U.S.
 hospitals: 66% of those are NV-HAP
- NV-HAP is costing more lives and dollars than any other HAI
- NV-HAP is a major contributor to:



- > Mortality
- > Morbidity
- > Readmissions
- ICU utilization
- Sepsis
- Length of stay
- Excess cost





Myth Busters

Who is "at-risk" for NV-HAP?

Common bias..."Oh well, pneumonia just happens, nothing much we can (or should) do about it", "It is something that the elderly get, you know, just at the end of life"

Myth Busters:

NV-HAP occurs in all types of:

- patients
- hospital units
- hospitals

NV-HAP occurs 51% of the time in patients under 65 years of age NV-HAP occurs in healthy adults admitted for restoration of health

This means – that while some patients have more risk ••• than others, all patients, on all type of units, in all types of hospitals are at some risk!







National Study: Baker & Quinn (2018). American Journal of Infection Control

Pathogenesis of NV-HAP





What is Hospital-Acquired Pneumonia?

Hospital-acquired = not present on admission & >48 hrs after admission

Acute lung inflammation due to infection Symptoms caused by inflammation and reduced ability to move oxygen

- Fever
- Shortness of breath
- Chest pain
- Cough
- Fatigue





Common Pathogens for HAP

- Bacteria (75%)
 - Gram-negative bacilli:
 - Pseudomonas aeruginosa, Proteus, Acinetobacter, Enterobacter, Klebsiella, • Escherichia coli, Serratia marcescens, Strep pneumoniae, Haemophilus influenzae)
 - Gram-positive:
 - Staph aureus (MSSA, MRSA)
- Viruses (<25%) ٠
 - H. influenza
 - RSV
- Fungi (rare) ۲

ter Health

- Endemic or opportunistic
- E.g. Aspergillus, Candida
- May vary significantly among institutions (antibiogram) .



By Nephron - Own work, CC BY-SA 3.0, https://commons.wikimedia.org/w/index.php?curid=9097954

Kalil AC, Metersky ML, Klompas M, et al: Management of adults with hospital-acquired and ventilator-associated pneumonia: 2016 clinical practice guidelines by the Infectious Diseases Society of America and the American Thoracic Society. Clinical Infectious Diseases 63(5):e61-111, 2016.

Pathogenesis of Pneumonia





Quinn & Baker. (2014). J Nsg Scholarship, 46(1), 11-19. CDC & HCPAC Guidelines, 2003

1. Pneumonia pathogens in the oropharynx: Who is at risk?

- Acidosis lacksquare
- Alcoholism
- **Antibiotics** •
- Azotemia
- Coma
- Diabetes ullet
- ET/NGT in place
- Hypotension
- Leukocytosis or Leukopenia
- **Malnutrition** •
- Pulmonary disease ${\bullet}$
- Severe illness
- Surgery





http://th00.deviantart.net/fs20/PRE/f/2007/307/a/a/Mouth_Shout_by_Helewidis_stocks.jpg

Quinn & Baker. (2014). J Nsg Scholarship, 46(1), 11-19.

Most Pneumonia Starts in the Mouth

Microbiome of Oral Cavity •

- 200 Billion oral microbes
- 500-650 species ____

Disruption of Microbiome •

- Risk with hospitalization —
- <48 hours to see a change in oral microflora toward pathogenic bacteria



http://helios.bto.ed.ac.uk/bto/microbes/biofilm.htm



Loesche, W. 2012

2. Aspiration: Who is at Risk?

- Decreased level of consciousness
- Impaired swallow
- Reduced cough/gag reflex
- Presence of tubes
 - Respiratory
 - GI
- Supine position
- Who else? •

Gleason et al, 1997. Chest 111(5): 1266-72







3. Weak Host: Who is at Risk?

- Male
- Elderly
- Surgical
- Chronic disease
 - DM, Heart disease, CKD, COPD, alcoholism, stroke, cancer, Alzheimer's
- Immunocompromised
- More than 6 medications
- Low albumin
- On antibiotics
- Dependent for ADLs
- Smokers





ALTHOUGH SOME PATIENTS ARE AT HIGHER RISK FOR NVHAP THAN OTHERS, ALL PATIENTS ARE AT SOME RISK!





PREVENTION





"Identify the most modifiable risk factors and develop prevention programs to address them." (CDC, 2003)





How Can We Reduce Oral Pathogens?

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Figure 5. Primitive Communication System. The bacteria in a biofilm use chemical signals to communicate with each other.

Kellum et al 2007Understanding inflame cytokine response in PNA and sepsis GenIMS Arch Intern Med. 2007;167(15):1655-1663

Mechanical removal of biofilm • (plaque) = tooth brushing

In addition to germs growing... Germ colonies develop chemical communication to secrete proinflammatory cytokines that reduce immune response





A Word About Chlorhexidine Gluconate (CHG) Oral Rinse



- CHG -- effective antimicrobial against oral pathogens and prevents HAP in cardiac surgery patients
- BUT CHG is not without risk: \bullet
 - Overuse can result in antibiotic resistance and loss of this weapon
 - May cause increased mortality risk
- New recommendations:
 - Cardiac surgery, sick vented patients
 - Do NOT use on low-risk patients

Kampf (2016) Acquired resistance to CHG – is it time to establish an antiseptic stewardship initiative? J of Hosp Inf. 94;213-227 Klompas (2014) Reappraisal of Routine oral care with CHG for patients receiving mechanical ventilation: systematic review and meta-analysis. JAMA, 174(5); 751-761.



Bouadma & Klompas (2018) Ed Oral care with CHG beware. Intensive Care Medicine.





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Oral hygiene—best bet so far To reduce oral pathogens and prevent NV-HAP

Sjogren et al. 2008

 Systematic review - Mechanical oral hygiene has a clinically relative preventive effect on pneumonia; prevents pneumonia and death

Passaro et al. 2016 (6 studies)

 Systematic review - oral hygiene most effective to prevent HAP compared to other interventions

Lyons & Kollef 2018

Review of interventions to prevent pneumonia. Prevention of HAP – so far most likely intervention to decrease HAP but variety of oral care methods tested.







Recommended Oral Care Supply List

- Soft bristled toothbrush
- Toothpaste with fluoride (sodium bicarb, optional)
- Antiseptic mouth rinse, alcohol-free
- Mouth and lip moisturizer
- Special equipment for other patient needs:
 - Denture supplies
 - Suction toothbrushes for dependent/aspiration risk
 - Bite block for those unable to keep mouth open for oral care



https://www.mouthhealthy.org/en/az-topics/b/brushing-your-teeth



https://cdn.pixabay.com/photo/2017/05/28/18/56/dentist-2351844_960_720.png

American Dental Association-Approved: Oral Care Protocol for Adult Acute Care Hospital Patients

Patient Type	Tools	Procedure	Frequ
Self Care / Assist	Brush, paste, rinse, moisturizer	Provide tools Brush 1-2 minutes Rinse	2-4 X /
Dependent / Aspiration Risk / Non-vent	Suction toothbrush kit (4)	Brush & suction 1-2 minutes	2-4 X /
Dependent / Vent	ICU Suction toothbrush kit (6) CHG	Brush/Swab & suction 1-2 minutes	6 X / d CHG 2
Dentures	Tools + Cleanser Adhesive	Remove dentures & soak Brush gums, mouth Rinse	2 X / d



American Dental Association–Approved 2017 Protocol for the Use of Evidence-Based Oral Care in the Acute Care Setting (Quinn B, & Baker DL (2015). Comprehensive oral care helps prevent hospital-acquired nonventilator pneumonia. American Nurse Today, 20(1): 18-23.)





"Identify the most modifiable risk factors and develop prevention programs to address them." (CDC, 2003)





2. Reduce Aspiration

- A. Swallow screening
- B. Elevate head of bed (HOB)
- C. Nasogastric / Orogastric tube management





Swallow Screen

- Identifies patients at risk for aspiration
- Pass/Fail
- Patients to screen:
 - Stroke, neurodegenerative disorders, post extubated, history of dysphagia
- Use a validated tool
 - E.g. Yale Swallow Protocol



Jiin-Ling Jiang 2016 Edmiaston 2010 Perren 2019 AACN 2016



Elevate HOB



http://opentextbc.ca/clinicalskills/wp-content/uploads/sites/82/2015/09/degreeLow-300x200.jpg

- Avoid supine position in at-risk patients
- Low-level evidence
- Unknown benefit of 45 vs. 25 degrees

Blot SI, Poelaert J, Kollef M. How to avoid microaspiration? A key element for prevention of ventilator-associated pneumonia in intubated ICU patients. BMJ Infect Dis.2014;14:119. doi:10.1186/1471-2334-14-119



NG / OG Tube Management

- Presence of NG/OG tubes increase risk for aspiration
- Assess clinical need Q shift & discontinue ASAP
- Mitigate risk of aspiration with enteral feeding:
 - Elevate HOB 30-45 degrees
 - Judicial use of sedatives
 - Assess feeding tube placement Q 4 hours
 - Assess feeding tolerance Q 4 hours
 - Avoid bolus feedings in at-risk
 - Swallow eval after extubation

American Association of Critical-Care Nurses. AACN practice alert: preventing aspiration. Crit Care Nurs. 2016;36(1): e20-e24



patientshttps://upload.wikimedia.org/wikipedia/commons/thumb/1/19/Dia gram_showing_the_position_of_a_nasogastric_tube_CRUK_340.svg/90 0px-Diagram_showing_the_position_of_a_nasogastric_tube_CRUK_340.svg .png



"Identify the most modifiable risk factors and develop prevention programs to address them." (CDC, 2003)





Strengthen Host Defenses

- Early mobility
- Ensure adequate nutrition
- Acid-reducing medication stewardship
- Glycemic control
- Immunize





Stronger Together

Mobilize

- Immobility in acute care is common
 - 87%-100% of a patient's time in acute care is spent in bed (Fazio, 2019)
- Immobility is correlated to negative outcomes
 - DVT, pneumonia, functional decline, delirium, extended LOS, cognitive impairment, increase risk of death
- Early mobility is correlated to improved outcomes, including reduced risk of pneumonia



Fazio Wood Kalisch BJ, et al. Journal of Clinical Nursing, 2013;23:1486-1501 Craig et al (2015)



Provide Nutrition

- Adequate nutrition while in hospital contributes to a decrease in skin injuries, infections, and length of stay
- Malnutrition in hospitalized patients is a significant risk factor for pneumonia outside ICU (Sopena 2014)
- In one study enterally-fed patients in ICU received less than 50% of prescribed goal





Stress Ulcer Prophylaxis (SUP) Stewardship

- The most common complication of SUP is pneumonia
- ICU enteral fed patients •
 - no benefit & may increase risk for pneumonia (Huang study)
 - Avoid unnecessary use
- Acute Stroke patients (Systematic Review & Meta-Analysis)
 - Acid suppressive medications are an important contributor to pneumonia development, especially PPIs
- May lead to loss of protective bacteriostatic effect of gastric acid ${\color{black}\bullet}$
- Higher risk of Clostridium difficile infection when combined with • antibiotics



Huang et. al (2018) Stress ulcer prophy in ICU pts receiving EN: Systematic review & meta-analysis. Critical Care 22(20), 1-9. Herzig et. AI (2014) Acid suppressive med use in acute stroke and HAP. Ann Neurol. 76(5): 712-178. Marchina et al (2019) ASM and risk of pna in stroke: Syst Rev & Meta analysis. J of the Neurological Sciences, 400;122-128.





Glycemic Control

- Patients with diabetes are more likely to develop infections compared to general population
- Hyperglycemia is associated with increased inflammation & susceptibility to infection
- Hospitalized patients with glucose levels >180 were associated with pneumonia (Jeon study)



Weintraub (2019) Susceptibility to infections in persons with DM. *Up To Date* last updated Jul 11, 2018. Kittelson (2009) Glycemic control: a lit rev w implications for perioperative nursing practice. 90(5);714-730. Jeon et al (2012) Post adm gluc levels assoc w HCA BSI and Pna in hospitalized pts w DM. *J of Diabetes and its Complications*. 26(6);517-521.



Screen and Immunize

- Vaccines are underutilized in the U.S. lacksquare
 - CDC recommends screening and immunizing hospitalized patients in an effort to increase the rate
- Patients receiving the influenza vaccine have a lower risk for hospitalization ulletand complications
- Vaccinations are effective in reducing death and complications for patients with lacksquarediabetes



CDC, Advisory Committee on Immunization Practices (ACIP) Retrieved 11.15.19 : https://www.cdc.gov/vaccines/acip/index.html Nichols MK, Andrew MK, Hatchette TF et al. (2018) Influenza vaccine effectiveness to prevent influenza-related hospitalizations and serious outcomes in Canadian adults over the 2011-12 through 2013/14 influenza seasons: A pooled analysis from the Canadian Immunization Research Network (CIRN) Serious Outcomes Surveillance (SOS Network), Vaccine, 36(16:216602175. Husein N, & Woo V (2013) Influenza and pneumococcal immunization, Canadian Journal of Diabetes, 37:S93-S93.



Figure 1: Statistical process control R and X-bar-charts: International Statistical Classification of Diseases and Related Health Problems (ICD) codes (3 standard deviations)





Baker, Quinn, Ewan, Giuliano (2018) Sustaining quality improvement: LT reduction of NVHAP. J Nurs Care Qual, 1-7.

What does prevention mean?

- Between May 2012 and December 2014
- Sutter Medical Center avoided 164 cases of NV-HAP:
 - **\$5.9 million**
 - **31 lives**
 - 656-1476 extra days in the hospital







3 Steps YOU can Take to Address NV-HAP









Outcome Measures	Process Measures	Options for I HAP
% NVHAP (#NVHAP / #pts X 100)	Frequency of oral care delivered / per patient / day	International of Diseases (J12-18.9 min Pneumonitis
NVHAP/1000 pt days (#NVHAP / #pt days X 1000)	% eligible patients with swallow screens complete	ICD 10 NVHA definition for
NVHAP Count	% non-ICU patients with daily mobilization	Electronic clir in eHR
National Average: 1.22- 5.9/1000 pt days	% patients up in chair for meals	
1. Dat		



Measuring NV-

Classification (ICD-10) us CAP, VAP,

AP + NHSN NV-HAP

nical indicators

"In God we trustall others bring data."

Future State--Objective Surveillance Definitions for NV-HAP: Clinical Indicators in the EHR

	Worsening oxygenation	≥3 days of new antibiotics	Temp > 38ºC	White Blood Cell Count <4 or >12	Chest-X-Ray or CT Chest	Respiratory culture
Definition #1	\checkmark					
Definition #2	\checkmark	\checkmark				
Definition #3	\checkmark	\checkmark	Either			
Definition #4	\checkmark	\checkmark	\checkmark			
Definition #5	\checkmark	\checkmark	\checkmark	\checkmark		
Definition #6	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	
Definition #7	\checkmark	\checkmark	Either		\checkmark	
Definition #8	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark	\checkmark
Definition #9	\checkmark	\checkmark	Either		Either	
Definition #10	\checkmark	\checkmark	\checkmark	\checkmark	Eith	er

Klompas, et. al (2018). ID Week Poster



Gap Analysis











3. Manage the Change

- Utilize a scientific model to provide structure Include:
 - Sponsorship support
 - Communication
 - Education for staff and patients/families
 - Engagement of staff
 - Feedback
 - Accountability





"Hospital-acquired pneumonia in nonventilated patients: the next frontier."



Michael Klompas, 2016 Harvard Medical School, Dept. of Medicine, Brigham and Women's Hospital, Boston, MA



Summary

- 1. HAP is now the #1 hospital-acquired infection in U.S. hospitals - costing more lives and dollars than most other HAIs combined.
- 2. Prevention consists of identifying the modifiable risk factors and putting programs in place to decrease those risks.
- 3. As a Clinical Nurse Specialist, you can influence practice at the bedside and prevent NV-HAP by providing education, data, and leading process improvement efforts tter Health

"A year from now You will wish you had started today."

Karen Lamb



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