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„Wir können den Wind nicht ändern, aber die Segel anders setzen“ (Aristoteles)

Developping a new scoring system to predict the risk of multidrug resistant pathogens in hospital acquired pneumonia using big data analyses on DRG routine data

33d PCSI working conference and ABF PCSI 2017 conference

Session: Clinical Management in an activity based funding environment

Sydney, 12 Oct 2017

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Agenda

- Background & scientific research questions
- Material & Methods
- Results
- Discussion
- Conclusion & Outlook

Background

- Hospital-acquired (HAP) and ventilator-associated pneumonia are important disease entities that pose a major challenge in intensive care medicine
- Many reviews show that adequate initial therapy is key for success and survival
- Rate of inadequate therapy of of app. 40% in HAP (results of a recent literature review by our group)
- Correct assessment of the risk for multidrug resistant pathogens is key for choosing the right initial therapy
- The literature describes a large number of risk factors

Risk factors derived from the literature (n=33)

antimicrobial therapy in the last 60 days	operational procedures
current hospitalization of 5 days or more	trauma
high frequency of antibiotic resistance	torso storage
residence in a nursing home or extended care facility	intravenous treatment
home infusion therapy (including antibiotics)	acid blocker
chronic dialysis within 30d	gender
home wound care	stay ICU
family member with multidrug-resistant pathogen	malnutrition
immunosuppressive disease	Late Onset Pneumonia
immunosuppressive therapy	Cerebrovascular disease
age >65	dysphagia
coma	aspiration
intubation	Diabetes
tracheostoma	chronic renal failure
mechanical ventilation	tube feeding
organ failure and septic shock	History of MDR infection or colonization (1yr)
pre-existing disease of the respiratory tract/structural lung disease / severe COPD	

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Scientific questions in this study

1) Can the risk factors identified in the literature be described by the use of ICD classifications and German operation codes (OPS)?
2) Are we able to validate the risk factors on a large data set of DRG routine data?
3) Is it possible to develop and a risk scoring system based on routine data that is able to predict the presence of multidrug resistant bacteria in both disease entities?

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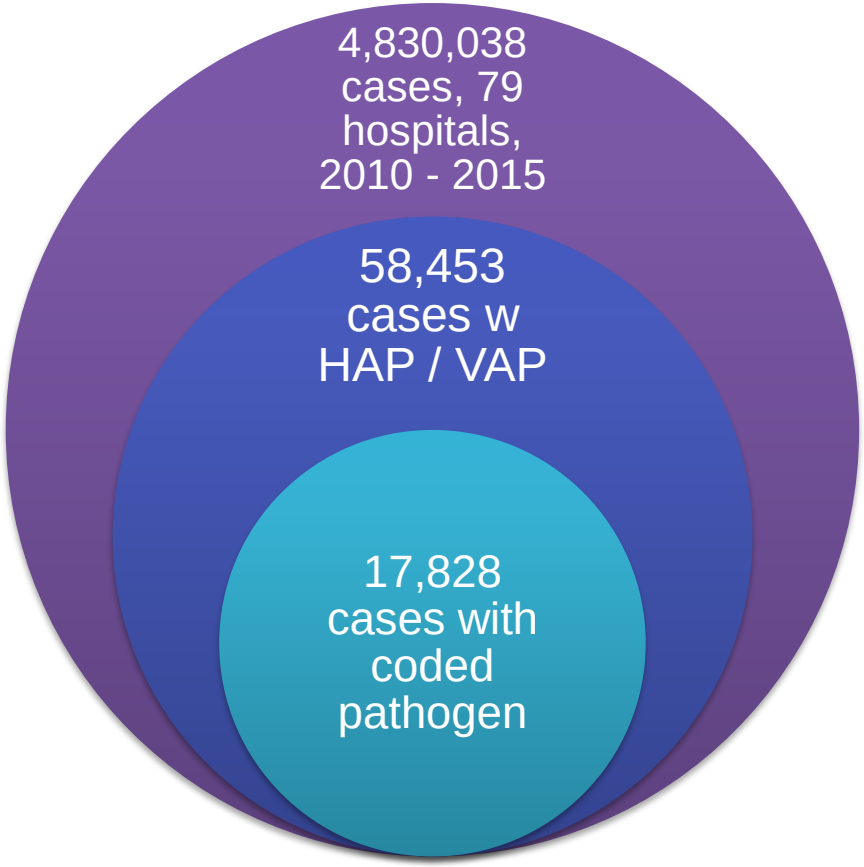
Material & Methoden

Database

The data was taken from a DRG Registry of the German Society of Gastroenterology (DGVS), where data from cost calculating hospitals are collected, analyzed and used for DRG improvement recommendation



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Materials & Methods
Further steps

- Determine whether or not an MDR – pathogen is coded
  - MRSA
  - VRE
  - ESBL
  - KPC
  - Other multidrug resistant gram-negative (MRGN)
  - If yes: “Flag case” as “MDR”

- Divide sample in two groups
  - HAP/VAP with and w/o MDR

Materials & Methods

- Data analysis was performed using SPSS version 19
- Univariate analysis of categorical variables was performed using the chi-squared test
- A P value of < 0.05 was considered significant, all analyses were two-tailed
- All variables significant at a P value of < 0.05 in univariate analysis were entered into a logistic regression model, using the forward method
- Based on the resulting odds ratio (OR) a score value was assigned (e.g. 1.2 = 2; 1.3 = 3; etc.)

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Results
baseline characteristics

Charakteristika	MRE Gruppe	non MRE-Gruppe	Sig.
Fallzahl	2.091 (11,7%)	15.737 (88,3%)	
Geschlecht (m/w)*			,011
männlich	1.499 (71,7%)	10.807 (68,7%)	
weiblich	592 (28,3%)	4.919 (31,3%)	
Ø Alter (+/- SD)	66,65 (+/- 14,207)	65,53 (+/- 15,200)	,944
Mortalität	698 (33,4%)	4.178 (26,5%)	,000
Ø Verweildauer (+/- SD)	51,19 (+/- 41,032)	36,48 (+/- 32,910)	,000
Hauptdiagnose nach ICD-10 - Top 10			,000
1 Bestimmte infektiöse und parasitäre Krankheiten	127 (6,1%)	729 (4,6%)	
2 Neubildungen	307 (14,7%)	2.442 (15,5%)	
4 Endokrine, Ernährungs- und Stoffwechselkrankheiten	68 (3,3%)	565 (3,6%)	
6 Krankheiten des Nervensystems	74 (3,5%)	442 (2,8%)	
9 Krankheiten des Kreislaufsystems	602 (28,8%)	5.657 (35,9%)	
10 Krankheiten des Atmungssystems	190 (9,1%)	1.097 (7,0%)	
11 Krankheiten des Verdauungssystems	304 (14,5%)	1.557 (9,9%)	
13 Krankheiten des Muskel-Skelett-Systems und des Bindegewebes	53 (2,5%)	286 (1,8%)	
14 Krankheiten des Urogenitalsystems	61 (2,9%)	338 (2,1%)	
19 Verletzungen, Vergiftungen und best. andere Folgen äußerer Ursachen	250 (12,0%)	2.192 (13,9%)	
Intensivbehandlung	1.750 (83,7%)	12.009 (76,3%)	,000
Partition			,000
Operativ	1.782 (85,2%)	12.727 (80,9%)	
Medizinisch	251 (12,0%)	2.393 (15,2%)	
Andere	58 (2,8%)	617 (3,9%)	
Komorbidität			
Septischer Schock	1.005 (48,1%)	5.402 (34,3%)	,000
Organversagen Niere	825 (39,5%)	4.435 (28,2%)	,000
Organversagen Kreislauf	606 (29,0%)	3.528 (22,4%)	,000
Organversagen Lunge	1.669 (79,8%)	11.502 (73,1%)	,000
Organversagen Gerinnung	389 (18,6%)	2.787 (17,7%)	,316

*11 Fälle (0,1%) mit unbestimmten Geschlecht in der non-MRE Gruppe

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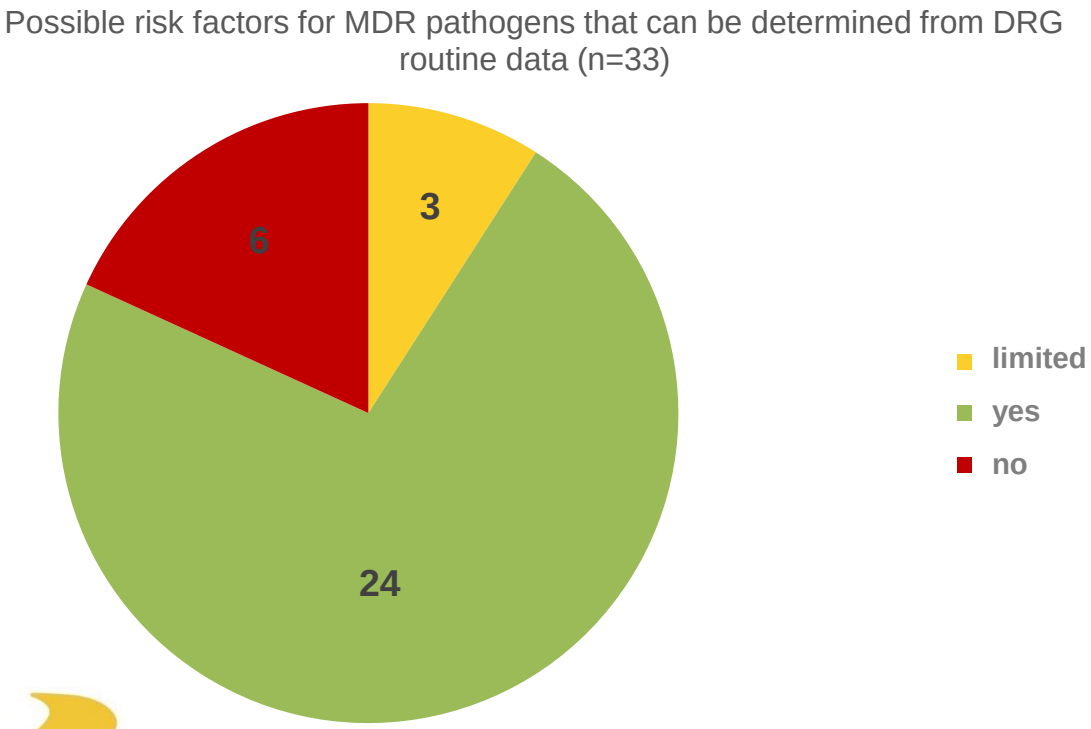
Results
Risk factors

- 24 of the identified risk factors could be described by the use of routine data (via ICD-10, OPS-codes or other datapoints)



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Results
Risk factors

Possible risk factors for MDR pathogens that can be determined from DRG routine data:

age
gender
mechanical ventilation
immunosuppressive therapy
respiratory insufficiency
chronic dialysis
stay ICU
malnutrition
tube feeding
chronic disease of the respiratory tract
COPD
frequent infusions via catheter retention system

organ failure and septic shock
diabetes
dementia
surgical procedure
Tracheotomy and tracheotomy after day 4 (as proxy for late onset)
polytrauma
torso storage
central venous catheter
hyperglycemia
cerebrovascular diseases
bad health condition
readmission into the same hospital within 30 days

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Results
Risk factors pneumonia

		Sig.	Odds ratio (OR)	95% CI for OR	
				lower	upper
Step 8	Age > 65	,004	1,155	1,047	1,274
	Dialysis patient	,082	1,179	,979	1,419
	Ventilation < 6 days	,026	,717	,536	,960
	Ventilation >= 6 days	,001	,659	,509	,852
	septic Shock	,000	1,230	1,105	1,369
	Central venous line	,078	,895	,791	1,013
	Intensive care	,032	1,340	1,025	1,752
	Intesive care complexity score coded	,001	1,000	1,000	1,000
	Tracheostomy	,000	1,430	1,266	1,615
	Late Onset	,000	1,243	1,121	1,378
	Bronchoscopy	,013	,877	,790	,973
	Cerebrovascular diseases	,000	,726	,647	,815
	Tube feeding	,071	1,105	,991	1,233
	Skin- and soft tissue infections	,000	1,310	1,179	1,454
	Chronic liver disease	,004	,802	,692	,930
	Emergency bowel surgery	,003	1,437	1,128	1,830
	MDR pathogen carrier	,000	1,372	1,175	1,602
	MDR rate of all pathogens in HAP > 7%	,000	1,342	1,213	1,485

PLUS: „**Prior antimicrobial therapy in the last 30 days**“ → OR = 8

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Results
Risk factors pneumonia

Risk factor	Score Value (derived from Odds ratio)
Age > 65	2
prior antimicrobial treatment in the last 30 days	8
septic Shock	2
ICU treatment	3
Tracheostoma	4
Late Onset (>4 days in hosp.)	2
cSSTI	3
emergency bowel surgery	4
MDR pathogen carrier	3
MDR rate of all pathogens in HAP > 7%	3
Maximum Score	**34**

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Results – Risk Scoring
Quality of the model

Predictive values at a cut-off of ≤ 19 (11) Scoringpoints:

	MDR present	NO MDR present			
Score indicates "MDR"	1325	6650	7975	positive predictive Value (PPV)	**16,61%**
Score indicates "No MDR"	766	9087	9853	negative predictive Value (NPV)	**92,23%**
Total	2091	15737			
	Sensitivity	Specificity			
	63,37%	**57,74%**			

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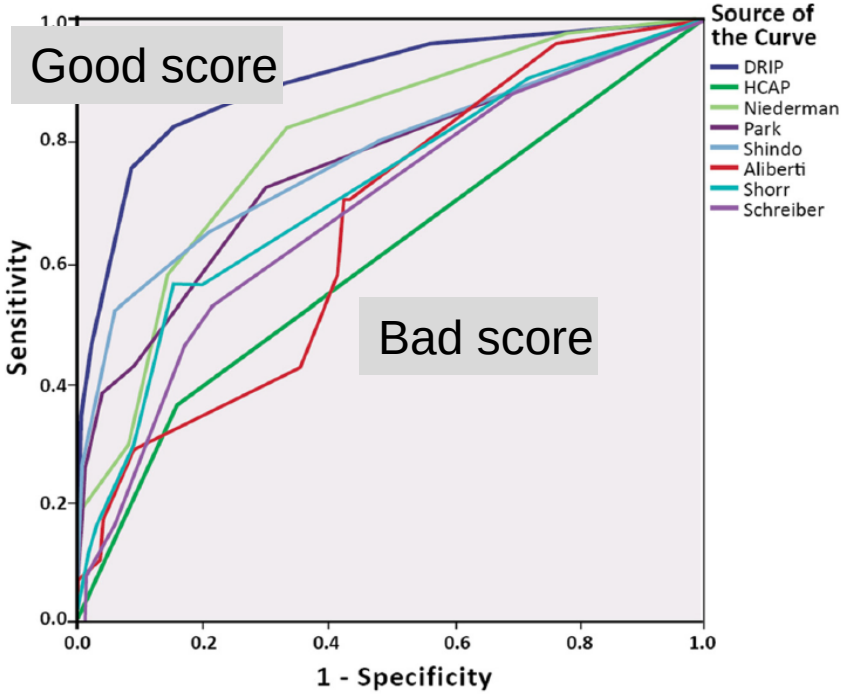
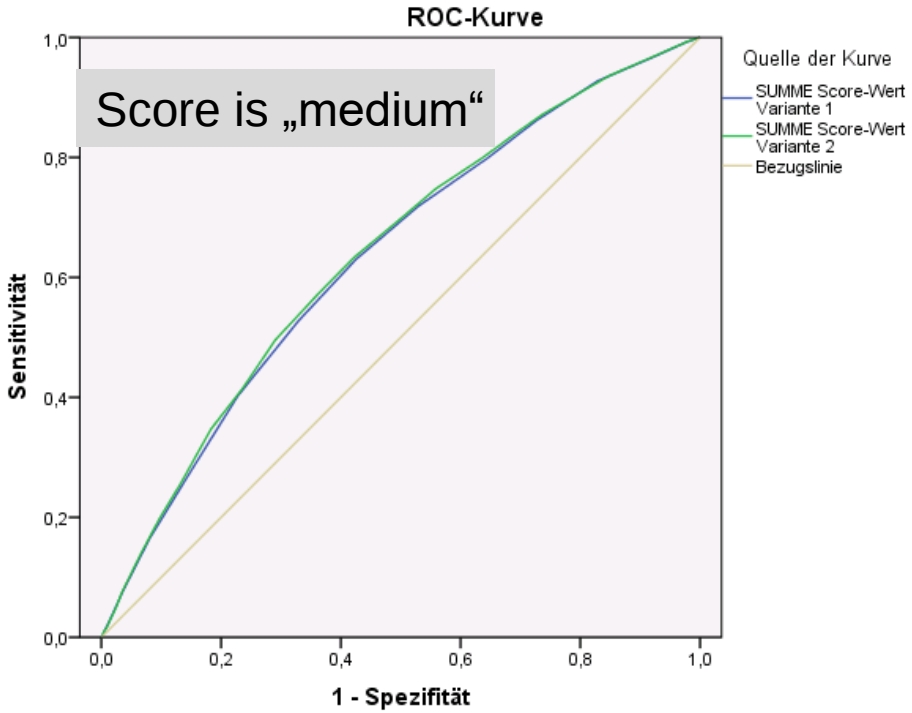
Discussion

Comparison of our Score with other scores (unfortunately all for „healthcare associated pneumonia)





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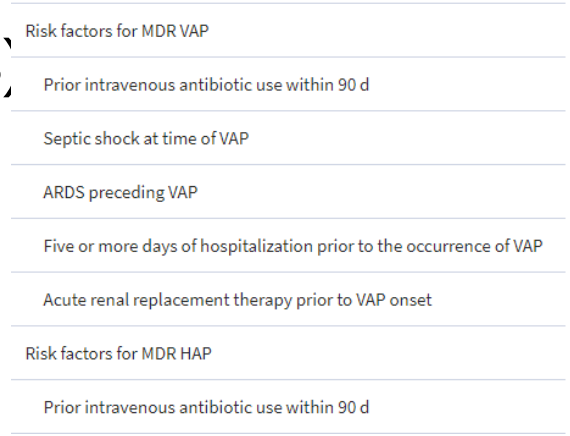
Discussion
Comparison to other guidelines

- Current German Guideline (2013) → Cover MDR if occurence rate is > 20%
- PEG Guideline (DACH-countries, historically ‚*eminence-based*‘) Risk score (2017)
  - Score has pretty much the same items (except COPD)
  - COPD not in our score
  - We have different values (weights)
- IDSA Guidelines (2016)
  - Cover MDR, if one RF is present



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Discussion
Risk factors derived from routine data

- Risk factor analysis and validation is possible – in principle
- Open questions
  - How to deal with risk factors that can be “cause” or “consequence”?
  - How to validate the prior antibiotic therapy which is (in Germany) unavailable?
- Current score has a high NPV = if the Score says “NO MDR” you can be pretty much rely on it
- however due to low PPV certain overtreatment could occur
  - clear need for pathogen detection through microbiology
  - **de-escalation of antimicrobial therapy after pathogen detection**

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Conclusion & Outlook

- The description of risk factors by the use of routine data is technically feasible
- Computing the score on ‚big data' is also possible
- Now: prospective validation has to follow
  - Currently some hospitals in Germany declared their interest to prospectively validate the score
  - Score and Info how to use it were sent
  - Results will be available in 2018

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