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# Validation of Published Risk Predictive Models for Carbapenem-resistant Enterobacteriaceae Identification in Hospitalized Patients

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### OBJECTIVE

The objective of this study is to evaluate the reliability of existing CRE risk predictive models with the aim to identify patients at risk and provide timely appropriate empiric antimicrobial therapy.

### BACKGROUND

Carbapenem resistant Enterobacteriaceae (CRE) infections are increasing and are urgent threat by the Centers for Disease Control and Prevention.  
CRE infections are challenging to treat and often result in high morbidity and mortality. Early and accurate prediction of patients with CRE infections can help guide appropriate empiric and CRE treatment and improve patient care.  
Clinical predictive models are available to estimate CRE infection probability and may help guide empiric therapy treatment in individual.

### METHODS

Study design: Retrospective, cross-sectional (RCS) study.  
Study location: Mount Sinai West (MSW) and Mount Sinai Morningside (MSM).  
Study population: Adults inpatient and outpatients.  
Study period: January 2018 to December 2019.  
Statistical analysis will be carried out using the following:  
Table 1. Overall predictive models and associated risk factors/predictors

### METHODS

Table 1. Overall predictive models and associated risk factors/predictors

Kim et al. <sup>1</sup>	Seligman et al. <sup>2</sup>	Vazquez et al. <sup>3</sup>	Yang et al. <sup>4</sup>	Weston et al. <sup>5</sup>
<ul style="list-style-type: none"> <li>CRP</li> <li>ORF</li> <li>Respiratory therapy</li> <li>Parenteral therapy</li> <li>Enteral nutrition</li> <li>Diabetes</li> <li>Underweight</li> <li>Use of antibiotics within 10 days prior to diagnosis</li> </ul>	<ul style="list-style-type: none"> <li>Phonemotor or Adrenergic</li> <li>Age</li> <li>CRP before antibiotics</li> <li>Unknown source of infection</li> <li>Transfer from hospital</li> <li>Abnormal oxygen</li> <li>Hospital stay before infection</li> <li>70%</li> <li>Prior antibiotics</li> </ul>	<ul style="list-style-type: none"> <li>Male gender</li> <li>Cardiovascular disease</li> <li>Recent admission to ICU</li> <li>Urinary catheter</li> <li>Mechanical ventilation</li> <li>APACHE II score</li> <li>Admitted for &gt; 3 days</li> <li>Carbapenem therapy</li> </ul>	<ul style="list-style-type: none"> <li>Prior CRE culture within prior 180 days</li> <li>Mechanical ventilation</li> <li>Admission from SNF</li> <li>PTI within prior 30 days</li> <li>Liver disease</li> <li>Admitted for &gt; 3 days</li> </ul>	<ul style="list-style-type: none"> <li>Prior CRE culture within prior 180 days</li> <li>Mechanical ventilation</li> <li>Admission from SNF</li> <li>PTI within prior 30 days</li> <li>Liver disease</li> <li>Admitted for &gt; 3 days</li> </ul>

### RESULTS

Table 2. Baseline Demographics

Characteristic	MSW	MSM
Age (mean)	68.5	65.2
Male (%)	52.1	48.9
ICU admission (%)	35.4	31.2
APACHE II (mean)	12.3	11.8
CRP (mean)	10.5	9.8
Underweight (%)	15.2	14.1
Diabetes (%)	22.1	21.5
Respiratory therapy (%)	18.7	17.9
Parenteral therapy (%)	12.3	11.5
Enteral nutrition (%)	8.9	8.2
Diabetes (%)	21.5	20.8
Underweight (%)	14.1	13.5
Use of antibiotics within 10 days (%)	15.2	14.1

Figure 2. Area Under the Receiver Operating Characteristic Curves of Clinical Predictive Models

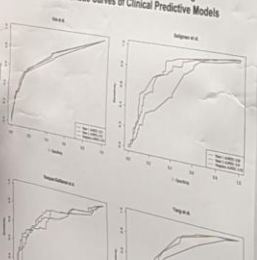


Table 3. Intraclass correlation (ICC)

Model	ICC	ICC P-value
Kim et al.	0.56	<0.01
Seligman et al.	0.62	<0.01
Vazquez et al.	0.56	<0.01
Yang et al.	0.62	<0.01
Weston et al.	0.67	<0.01
Our study	0.67	<0.01

### RESULTS

Table 4. Predictive Performance at Various Cutoffs

Cutoff	True Positive Rate	False Positive Rate
<b>Kim et al.</b>		
0.98	5.6%	0.0%
0.94	21.9%	3.3%
0.92	28.1%	4.4%
0.82	57.3%	16.7%
0.71	79.9%	46.7%
0.5	100.0%	100.0%
<b>Seligman et al.</b>		
0.75	2.2%	2.2%
0.66	25.8%	8.9%
0.27	79.8%	33.3%
0.19	89.9%	37.8%
0.14	95.9%	67.8%
0.09	98.8%	100.0%
<b>Vazquez et al.</b>		
0.83	33.7%	8.6%
0.86	52.8%	11.1%
0.70	89.7%	31.1%
0.56	85.4%	81.1%
0.40	91.0%	83.3%
0.44	96.6%	91.1%
0.27	100.0%	100.0%
<b>Yang et al.</b>		
0	27.0%	4.4%
1	61.8%	24.4%
3	68.9%	80.0%
5	100.0%	100.0%
<b>Weston et al.</b>		
0.96	4.4%	0.0%
0.79	27.0%	5.8%
0.41	77.5%	40.0%
0.29	84.9%	45.8%
0.10	95.5%	94.4%
0.01	100.0%	100.0%

### CONCLUSION

Our study included about 56% CRE positive patients. History of hospital admission, CKD, liver disease, in-hospital mortality, ventilation, length of stay, dialysis, urinary catheter, mechanical ventilation, carbapenem use, and targeted treatment significantly differed between the two groups.

The predictive models ability to discriminate showed some variation as indicated by the AUROC. For the five models assessed, AUROC ranged from 0.66 to 0.67, with Seligman et al. having the highest score. Also, all cut-off values 0.19, Seligman et al. seems most desirable in identifying patients at risk of CRE infection and minimal chance of under and over treatment.

On the other hand, intraclass correlation values of Kim et al. and Yang et al. showed good correlation and rater agreement.

Future plans should include increasing sample size and selecting optimal cut-off values to identify CRE patient.

### REFERENCES

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