Indicator Modeling for evaluating ICU physician's performance

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Introduction

- 360 evaluations are used to develop ICU metrics to reflect the performance of a healthcare system.
- The 360 evaluations are useful, but fail to consider additional sources of data (e.g. patient specific outcomes including ICU or hospital length of stay, complications, and mortality)
- The SOFA(Sequential Organ Failure Assessment) score is very important for ICU physicians to diagnose patient's organ dysfunction and organ failure, so it can lead to shock and death if it is not evaluated accurately while staying in ICU. Therefore, SOFA scores are a good indicator for evaluating ICU physician's performance from admission at ICU to discharge.
- The aim of this study is to analyze how physician/patient outcomes and 360 evaluation influence SOFA scores at admission and discharge based on their characteristics.

Are there patient and physician characteristics influencing SOFA scores at different time points in the ICU?

Key findings

SOFA Score at admission

- Medical Expert
- Non-Leadership
- Junior
- Surgical, Neuro ICU Department

Difference in SOFA Scores between admission and discharge

- Death Patients
- Medical Expert
- Scientific Knowledge
- Length of Stay

Methods

- We were investigated SOFA score following:
  - 360 evaluation
  - Patient's Characteristics
  - Physician's Characteristics
  - SOFA trajectory
- For each 360-evaluation category, mean average scores were calculated for each Physician's ID.
- We analyzed used t-test & ANOVA in hypothesis testing to determine whether the factors in datasets influence to SOFA score.
- Hierarchical Regression analyses were through to demonstrate any trends observed and to prove Pearson's correlation coefficients and determine the significance of each variable's relationships.
- All data that analysis had been analyzed using RStudio, MS Excel and SQL.

Data Exploration

Patient Characteristics

Table 1 – patient characteristics (n=2113)

			N(%)	Mean
Patient	Discharge Status	Alive	1125(53.2%)	
		Dead	988(46.8%)	
	Age	ge60	924(43.7%)	
		lt60	1189(56.3%)	
	Sex	Male	1262(59.7%)	
		Female	851(40.3%)	
	SOFA			23.17 ± 4.082
	APACHE-II			7.57 ± 2.697

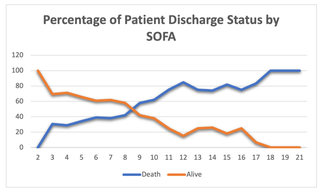
Physician Characteristics

Table 2 – physician characteristics by discharge status (n=2113)

	Discharge Status		Alive (Total SOFA)	Death (Total SOFA)
Physician	Rank	Junior	571(27%) (3896)	506 (23.9%) (4286)
		Senior	554 (26.2%) (3774)	482 (22.8%) (4036)
	Total		1125(53.2%)	998 (46.8%)
	Domain	Anesthesia	67(3.2%)	67(3.2%)
		Emergency	189 (8.9%)	132 (6.2%)
		Internal Medicine	568 (26.9%)	510 (24.1%)
		Medicine	142 (6.7%)	110 (5.2%)
		Neurology	72 (3.4%)	20 (0.9%)
		Pulmonary Medicine	87 (4.1%)	149 (7.1%)

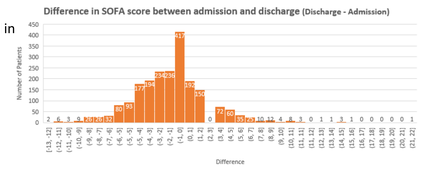
Total SOFA = Sum(SOFA) for junior or senior doctor

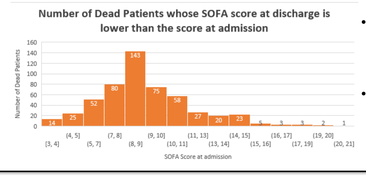
SOFA score by Discharge Status



- This graph shows that the higher SOFA score, the more patients die at discharge.

- 1535 patients had a decreased in SOFA score at discharge.





- Even if the SOFA score was lower SOFA score at discharge than at admission, 531 patients (25%) died.
- **There were 91 patients with SOFA scores lower than 7 but died at discharge despite SOFA lower than admission.**

Results

Table 3 -SOFA score according to patient and physician characteristics (n=2113)

			SOFA Score	p
Patient	Discharge Status	Alive	6.82	**< 2.2e-16**
		Dead	8.42	
	Diagnosis			**< 2e-16**
Physician	Age	ge60	7.32	**0.006**
		lt60	7.66	

<Table3> tells that younger physicians treat more fatal patients. Dead patients has higher SOFA score.

- **Significant Differences**
  - There is statistical difference between the means of discharge status group.
  - There is statistical difference between the means of physician's age.
- **Positive Correlation** to SOFA
  - ✓ The higher Medical Expert, Scientific Knowledge, and Professionalism scores, The higher SOFA score.

Table 4 -Correlation between evaluation categories and SOFA at admission (n=2113)

	Medical Expert	Advocacy	Scientific Knowledge	Professionalism	Communication	Collaboration	Management
SOFA	**0.0296**	-0.1038	**0.0132**	0.0682	-0.071	-0.060	-0.003

Physicians with higher medical expert, scientific knowledge, professionalism tend to treat more serious patients.

- **Relationship between SOFA and other variables**
  - ❑ Model 1 - 360 Evaluation included
  - ❑ Model 2 - Model 1 + Patient Characteristics included.
  - ❑ Model 3 – Model 1 + Model 2 + Physician Characteristics included.

Table 5 – Significant factors influencing SOFA at admission (n=2113)

	Model	Model I β	Model I *p*	Model II β	Model II *p*	*Model III* β	*Model III* *p*
360 Evaluation	Medical Expert	0.37	0.519	2.659	**2.04e-15**	2.1903	**5.44e-05**
Patient	APACHE-II			0.507	< 2e-16	0.544	**< 2e-16**
	Discharge Status-Dead			0.508	**2.39e-12**	0.5659	**2.50e-15**
	ICU Department-neuro			0.3426	**0.0003**		**0.001**
	ICU Department-surgical			1.018	**< 2e-16**		**< 2e-16**
Physician	Domain - neurology					1.68418	**9.88e-08**
	Leadership – leader_x					0.5339	**1.42e-05**
	Rank - senior					-0.272	**0.0199**
	Sex - Male					0.3364	**3.63e-05**
	R^2	0.016		0.684		0.729	
	Adjusted R^2	0.013		0.69		0.726	
	F(p)	5.17 (7.281e-06)		296.6 (< 2.2e-16)		224.9 (< 2.2e-16)	

Durbin-Watson : 1.5848 (p < 2.2e-16), Variance Inflation Factor (1 < VIF < 2)

- ❑ In Model 1, it shows R square is only 1% with 360 evaluation.
- ❑ In Model 2,patient characteristics variables are added. After then, R square is 68%, so 67% is increased from Model 1.
- ❑ In Model 3, physician characteristics variables are added. After then, R square is 72%, so 4% is increased from Model 2.

Results (Continued)

<Table5> may tell that the physicians with higher medical expert score tend to treat more fatal patients who tend to be dead. Also, physicians who are in neurology domain and junior and non-leadership position tend to treat more serious patients.

- There are different significant variables which influence difference in the SOFA score between admission and discharge.

Table 6 – Significant **factors influencing difference in the SOFA score between admission and discharge (n=2113)**

	Model	Model I β	Model I *p*	Model II β	Model II *p*	*Model III* β	*Model III* *p*
360 Evaluation	Medical Expert	-1.329	0.0732	-1.671	**0.01**	-3.970	**0.0007**
	Scientific Knowledge	-0.136	0.641	0.17	0.519	-1.619	**0.027**
	Collaboration	2.495	0.003	2.283	0.004	5.1415	**5.23e-08**
Patient	APACHE-II			-0.328	2e-16	-0.3072	**< 2e-16**
	Length of Stay			-0.068	0.068	-0.005	**5.73e-09**
	Discharge Status - DEAD			0.720	**5.97e-07**	0.449	**0.004**
Physician	Leadership – leader_x					-0.559	**0.017**
	Domain - internal medicine					1.6735	**0.025**
	Sex - Male					-0.678	**0.002**
	R^2	0.018		0.163		0.21	
	Adjusted R^2	0.014		0.159		0.20	
	F(p)	5.51 (2.664e-06)		37.3 (< 2.2e-16)		22.51 (< 2.2e-16)	

Durbin-Watson : 2.0818 (p < 0.9393), Variance Inflation Factor (1 < VIF < 2)

- ❑ In Model 1, it shows R square is only 1% with 360 evaluations.
- ❑ In Model 2, patient characteristics variables are added. After then, R square is 16%, so 15% is increased from Model 1.
- ❑ In Model 3, physician characteristics variables are added. After then, R square is 20%, so 4% is increased from Model 2.

<Table 6> may show that the lower the medical professional and scientific knowledge scores, the greater the difference in SOFA scores between hospitalization and discharge. This may be because ICU physicians with low medical expert and scientific knowledge scores do not properly evaluate SOFA scores during hospitalization. Those doctors tend to be in the internal medicine realm and leadership positions. Also, there tends to be more deaths in this case.

Conclusions

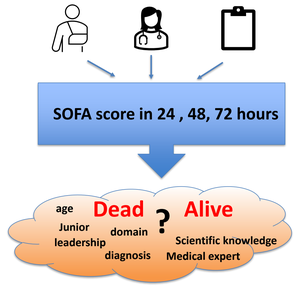
SOFA at ADMISSION

- Physician with high medical expert score on survey tend to have more serious patients.
- Physicians without leadership tend to have more serious patients.
- Physicians who are junior tend to have more serious patients.
- Physicians who are in neurology domain tend to have more serious patients.
- Physicians who are male tend to have more serious patients.
- Patients who are in surgical and neuro ICU department tend to have more serious condition.
- Patient who are in more serious condition tend to be dead.

SOFA between Admission and Discharge

- There are different significant factors when we look at the difference in SOFA scores between admission and discharge.
  - ✓ The lower medical expert and scientific knowledge scores on the survey, the greater the difference in the SOFA scores between admission and discharge.
  - ✓ The shorter length of stay in ICU, the greater the difference in the SOFA scores between admission and discharge.
  - ✓ The more dead patient at ICU, the greater the difference in the SOFA scores between admission and discharge.

What's Next?



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