Economic Burden Associated with *Streptococcus suis* Infection Treatment in Northern Thailand: A Hospital-based Observational Study

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Ajaree Rayanakorn[1-2]*, Wasan Katip[3], Zanfina Ademi[4-5], Kok-Gan Chan[6-7]*

[1]Faculty of Public Health, Chiang Mai University, Thailand; [2]School of Pharmacy, Monash University Malaysia, Jalan Lagoon Selatan, 47500, Bandar Sunway, Selangor, Malaysia; [3]Department of Pharmaceutical Care, Faculty of Pharmacy, Chiang Mai University, Thailand; [4]Centre for Medicine Use and Safety, Faculty of Pharmacy and Pharmaceutical Sciences, Monash University, Melbourne, VIC 3052, Australia; [5]School of Public Health and Preventive Medicine, Monash University; [6]Division of Genetics and Molecular Biology, Faculty of Science, Institute of Biological Sciences, University of Malaya, Kuala Lumpur, Malaysia; [7]International Genome Centre, Jiangsu University, Zhenjiang, China
*Email: ajaree.rayanakorn@cmu.ac.th; kokgan@um.edu.my

Background and Objectives

"Larb dib" or Traditional raw pork dish in a local market, Thailand

α -hemolytic mucoid colonies of *S. suis* on blood agar plates and Gram stains of an *S. suis* colony showing Gram-positive cocci.
Eric Gomez et al. J. Clin. Microbiol. 2014;52:2254-2258

- *Streptoccocus suis (S.suis)* is a zoonotic disease mainly in pigs which can cause serious infection in humans through exposure with pigs and consumption of raw pork.
- Thailand is the country with highest cumulative incidence of *S.suis* infection. However, no study has investigated the cost-of-illness from *S.suis* treatment and factors affecting the treatment costs in Thailand.
- This study aimed to estimate the direct medical costs associated with *S.suis* treatment in Thailand and identify key drivers affecting high treatment costs from the provider's perspective.

Methods

- A retrospective analysis of the 13-year data from 2005-2018 of confirmed *S.suis* patients admitted at Chiang Mai University Hospital (CMUH) was conducted.
- The multiple imputation with predictive mean matching strategy was employed to deal with missing data.
- Generalized linear models (GLMs) were used to forecast costs model. The modified Park test was adopted to determine the appropriate family.
- All costs were inflated applying the consumer price index for medical care and presented to year 2019.

Results

Table 1 Patient characteristics

Characteristics	Total (n=130)
Age (year) (mean±SD)	56.32± 13.77
Male	89 (68.46%)
Female	41 (31.54%)
GCS†	12.65± 3.15
SAPS II	27.22± 13.93
Risk behaviours	
- Alcohol drinking	66 (50.77%)
- Consumption of raw pork	49 (37.69%)
- Recent contact with pigs/pork exposure	5 (3.85%)
- Pig related occupation	3 (2.31%)
- Skin injury	2 (1.54%)
Signs and symptoms	
- Neck stiffness	46 (35.38%)
- Diarrhea	37 (28.46%)
- Vomiting	27 (20.77%)
- Vertigo	10 (7.69%)
Major clinical manifestations	
- Septicemia	73 (56.15%)
- Meningitis	48 (36.92%)
- IE	34 (26.15%)
- Septic shock	20 (15.38%)
Outcomes	
- Recovered	68 (52.31%)
- Recovered with sequelae	43 (33.08%)
- Having valve replacement	16 (12.31%)
- Death	16 (12.31%)
Mean length of stay (days)††	18.27± 17.26

GCS, Glasgow coma scale; IE, Infective endocarditis; SAPS II, The Simplified Acute Physiology Score
Note: †Available data from 101 patients; ††Available data from 128 patients

Results

- Among 130 *S.suis* patients (89 males, 41 females), the mean age was 56.32 ± 13.77 years.
- Septicaemia was the most common clinical manifestation (56%), followed by meningitis (37%) and infective endocarditis (26%).
- About half of patients recovered from the infection while around one-third had sequelae.
- The average admission duration was 18 days.

Table 2 Direct medical cost of *S.suis* treatment in the year 2019 value

Cost variables	Mean in THB (US$)	SD	Median	IQR
Overall (n=130)				
Medications	30,321.75 (US$ 976.64)	61,930.05	8,132.181	4,223.40-23,588.58
Laboratory tests	13,187.22 (US$ 424.75)	14,195.96	8,087.821	4,820.37-16,670.44
X-ray	8,239.51 (US$ 265.39)	12,487.7	4,039.29	714-9,828
Others (Room charges, meals, staff services, medical devices)	72,926.03 (US$ 2,348.89)	98,299.8	24,231.56	94,65.50-99,540.23
Average cost per episode	124,674.51 (US$ 4,015.67)	168,825.40	47,213.39	25,136.02-182,052.60
Total	16,207,676.40 (US$ 522,037.12)			

Table 3 Cost Model of *S.suis* treatment

Variables	Unstandardised Coefficients		t	Significant level	95% Confidence Interval for B	
	Beta	SE			Lower Bound	Upper Bound
Constant	333637.8	164,836.2	25.74	< 0.001	126687.2	878653.4
Infective Endocarditis	2.417703	0.4773245	4.47	< 0.001	1.641917	3.560039
GCS	0.9162752	0.0259905	-3.08	0.002	0.8667249	0.9686582
Length of stay	1.037278	0.0064089	5.92	< 0.001	1.024792	1.049915
Bicarbonate (mmol per litre)	0.9512553	0.0195557	-2.43	0.015	0.9136888	0.9903663

- The average total direct medical cost was 124,675 Thai baht (THB) (US$ 4,016), of which most expenses were from the "others" category (room charges, staff services and medical devices).
- Infective endocarditis (IE), GCS, length of stay, and bicarbonate level were significant predictors associated with high total treatment costs.
- Overall, marginal increases in IE and length of stay were significantly associated with increases in the total costs (standard error) by 132,443 THB (39,638 THB) and 5,490 THB (1,715 THB), respectively.
- In contrast, increases in GCS and bicarbonate levels were associated with decreases in the total costs (standard error) by 13,118 THB (5,026 THB) and 7,497 THB (3,430 THB), respectively.

Conclusions

- IE, GCS, length of stay, and bicarbonate level were significant cost drivers associated with direct medical costs.
- Patients' clinical status during admission significantly impacts the outcomes and total treatment costs.
- Early diagnosis and timely treatment were paramount to alleviate long-term complications and high healthcare expenditures.

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