

## Improving value driven outcomes in community acquired pneumonia: a multifaceted program in a university hospital

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### Background:

Community acquired pneumonia (CAP) has a significant impact on morbidity, mortality and economic burden (1). It is the second most common cause of death and fifth most common cause of hospitalization in Singapore. The overall mortality rate had been increasing from 16.8% in 2012 to 19.4% in 2015 (2). In 2005-2006, we implemented a series of long-term interventions to improve outcomes for CAP. We prioritized our improvement plan by initially targeting severe CAP which had the highest mortality, morbidity and healthcare costs. We collaborated with our emergency department to implement a timely multi-step resuscitative bundle in the emergency department which included identification of severe CAP based on the Infectious Disease Association of America (IDSA) and American Thoracic Society (ATS) guidelines in 2007, aggressive fluid resuscitation and appropriate empirical antibiotics. The multi-step interventions reduced mortality for this group of patients from 23.8% to 5.7% and reduced intensive care admissions and hospital days (3, 4). This effort is still being sustained to date. In January 2016, CAP was identified as a key project to be piloted in a hospital wide initiative in improving clinical outcomes, reducing costs and building a reporting tool called value driven outcomes (VDO) in which value was defined as the healthcare outcomes per dollar spent (5). We report the results at the first annual review of this VDO project.

### Methods and Interventions

A multi-professional team was assembled to improve VDO in CAP. This included the respiratory physicians, emergency department physicians, nurses and physiotherapists to implement a critical CAP pathway in 2016. The critical CAP pathway included the following elements: 1) risk stratification of severity and identification of severe community acquired pneumonia 2) fluid resuscitation 3) early and appropriate antibiotic administration 4) Appropriate disposition to the intensive care unit or general ward 5) standardization of appropriate investigations 6) early mobilization of elderly patients > 65 years of age and 7) standardization of discharge criteria. The pathway development was adapted from local experience prior, IDSA/ATS guidelines in 2007 (6) and the 3-step critical pathway described by Carratala et al (7). The clinical outcomes measured included inpatient mortality stratified according to the pneumonia severity index (PSI) developed by Fine et al (8), length of stay, length of stay targets for low risk pneumonia (PSI Class I-III) and high risk pneumonia (PSI Class IV and V) which was defined as 5 days or less and 14 days or less respectively and readmission rates within 15 days. Cost data of the patients were provided by our hospital finance department. The reporting tool for VDO was derived by our academic informatics office. Regular meetings were held with the inter-professional team to identify barriers, review progress and feedback on the team performance during the implementation phase. The data in 2015 (1 year prior to the implementation) and 2016 (during the implementation phase) were obtained and compared within the same division (Division of Respiratory and Critical Care Medicine; RCCM).

### Results

The clinical outcomes of the group managed by respiratory physicians were analyzed before and after the implementation of the pathway (table 1). There was no significant difference in the overall inpatient mortality when the pathway was implemented (7% in 2015 vs 6.5% in 2016). There was a reduction of the median length of stay in 2016 compared to 2015 from 4.3 days to 3.8 days (absolute 0.5 days;  $p < 0.05$ ). The percentage of which the length of stay targets were met were increased from 88.5% to 92.8% from 2015-2016. The readmission rates were not increased from 2015 to 2016 with the reduction in length of stay. The main cost drivers for community acquired pneumonia care in our hospital were the length of stay, investigations ordered and daily treatment costs including antibiotics. **There was a relative cost reduction of 18.8% after implementation of the critical pathway.** The cost per patient was adjusted for severity of the disease and median cost per patient for PSI Class I-IV was reduced except for PSI Class V (table 2).

	RCCM 2015	RCCM 2016	P value
Number of cases(n)	1142	1045	
Inpatient mortality: overall(%)	7	6.5	0.27
Mean LOS(days)	4.3	3.8	0.017
Target LOS met PSI I-III < 5 days PSI IV-V < 14 days (%)	88.5	92.8	0.002
Readmission rates within 15 days(%)	3.4	2.8	0.09

	RCCM 2015 (median cost per patient)(\$)	RCCM 2016 (median cost per patient)(\$)	Percentage Change(\$)
PSI II	2490	2089	-16.1
PSI III	2844	2323	-18.3
PSI IV	3224	2808	-12.9
PSI V	4164	4745	+14.0
	Relative cost reduction(%)		
Total Overall Cost (\$)	18.8%		

### Conclusion

Our team succeeded in improving the overall clinical outcomes and reduced costs thus improving the value of care delivered to patients with community acquired pneumonia. Between 2015 and 2016, there was an absolute reduction of the median length of stay for our patients of 0.5 days after the implementation of the pathway. This was consistent with studies showing a significant economic impact with a relatively small reduction of length of stay (9, 10). The improvement in VDO which we had observed was also comparable to that described by Lee et al (11) confirming that achieving better quality of care was possible with reduction of costs. Future challenges would include spreading and sustaining the improvement efforts to the usual care group which could potentially impact more patients with community acquired pneumonia in our hospital.

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