

## Characteristics in Thoracic Trauma Patients with Primary Chest Tube Affecting Length of Stay and Mortality Rate

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### Abstract

**Background:** Thoracic trauma is the third leading cause of death after abdominal trauma and head trauma. However, many studies show significant differences that affect morbidity and mortality. Severe injuries to the thorax can increase the mortality rate by 25% to 30%. This research was done in order to find predictor characteristics affecting the length of stay and mortality in thoracic trauma patients.<sup>[1,2]</sup>

**Method:** A Retrospective analysis was performed on thoracic trauma patients who had primary chest tube insertion initial therapy. Data were collected from June 2017 to October 2021 from medical records in Dr. Soetomo teaching hospital Surabaya. Chi-square was used to compare the variables, and Multivariabel Logistic Regression was used to identify independent predictor for length of stay and mortality. The independent predictors were demographics, complication, and surgical therapy during admission. P-value < 0.05 was considered statistically significant.

**Results:** There were 135 thoracic trauma patients that had primary chest tube insertion enrolled in this study. Traffic accident was the highest cause of the trauma (n = 97), and haemothorax, whether is it massive (n = 27) or not (n = 57), was the highest. Men were more frequent than woman (n = 110 vs 25). The youngest patient enrolled was 9 year, and the oldest was 90 years old. Statistically, extrathoracic injury was associated with prolonged length of stay (aOR 6.038; p = 0.007) and major+ POSSUM/P-POSSUM surgery severity was associated with mortality (aOR 36.484; p = 0.003).<sup>[3]</sup>

**Conclusion:** Traffic accident was still the primary cause of thoracic trauma with haemothorax as the most frequent complication. Prolonged stay was found on multitrauma patients, and patients having a severe surgery was predicted to have a high mortality rate.

**Key words** : Thoracic trauma, chest tube, hematothorax, pneumothorax, multitrauma

## INTRODUCTION

In the Global Status Report on Road Safety of the World Health Organization in 2018, it is stated that every year worldwide, more than 1.35 million victims are caused by traffic accidents and the average death rate is 27.5 per 100,000 population. . Of this number, 85% occur in developing countries.<sup>[4]</sup>

In Indonesia, according to the National Basic Health Research of the Ministry of Health in 2018 there were 92,976 trauma events during 12 months of observation, with various causes, with a thoracic trauma incidence of 2.6%.<sup>[5]</sup>

In multitrauma, thoracic trauma is the third leading cause of death after abdominal trauma and head trauma. However, many studies show significant differences that affect morbidity and mortality, so further research is needed to improve medical services. Severe injuries to the thorax can increase the mortality rate by 25% to 30%.<sup>[1,2]</sup>

Thoracic trauma is a wound or injury that affects the thoracic cavity or chest which can cause damage to the thoracic wall or the contents of the thoracic cavity (chest cavity) caused by sharp or blunt objects and can cause chest pain. Broadly speaking, thoracic trauma is classified into two, namely blunt thoracic trauma and penetrating thoracic trauma.<sup>[6,7,8]</sup>

In cases of thoracic trauma, often results in hypoxia, hypercarbia, and acidosis state. Therefore the primary goal treatment is to maintain ventilation of the lungs to achieve adequate tissue oxygenation, and this is generally difficult to achieve without chest decompression to reduce intra-pleural pressure while allowing the lungs to expand. Various literatures suggest options for thoracic injury management such as thoracocentesis, tube thoracostomy, and open thoracotomy. Among all, chest tube decompression remains the most efficient option with a complication rate of up to 30%. In the study by Bailey et al, the common indications for chest tube placement were pneumothorax (54%) and hemothorax (20%). An ideal chest tube placement is a safe procedure to perform and 80% of cases have adequate resolution.<sup>[9,10,11]</sup>

Many factors are predicted to influence the outcome of thoracic trauma patients, ranging from demographic data (gender and age), to the characteristics of the trauma itself (type of trauma, initial P/F ratio, posttraumatic complications, and the type of procedure/operation performed).<sup>[12,13]</sup>

## METHODS

A Retrospective analysis study was performed on thoracic trauma patients who had primary chest tube insertion as initial therapy were included as sample. Data were collected from June 2017 to October 2021 from medical records in Dr. Soetomo teaching hospital Surabaya, East Java, Indonesia.

The independent variables in this study were the type of trauma, age, gender, initial PaO<sub>2</sub>/FiO<sub>2</sub> ratio, rib fractures, pulmonary contusion, subcutaneous emphysema, tracheobronchial injury, extrathoracic injury, chest tube related infection, and sequel surgery (thoracotomy and/or other surgery). Sequel surgery according to the Operative Severity category from the Physiological and Operative Severity Score for the enumeration of Mortality and morbidity (POSSUM/P-POSSUM)). The control variable in this study was thoracic trauma with the cause of traffic accidents, work accidents, household accidents and crime resulting in pneumothorax, tension pneumothorax, hemothorax or massive hemothorax with primary chest tube insertion. The outcome in this study is the mortality rate and length of stay.

The data are presented descriptively with tables. Statistical analysis was performed using SPSS version 25 software (IBM, Armonk, NY). Chi-square was used to compare the variables, and Multivariabel Logistic Regression was used to identify independent predictor for length of stay

and mortality. The independent predictors were demographics, complication, and surgical therapy during admission. P-value < 0.05 was considered statistically significant.

## RESULTS

Of the 219 patients, there were 135 patients included as sample. The distribution of thoracic trauma with chest tube placement based on its type of trauma is described in table 1. Trauma due to traffic accidents is the most common type of trauma, which is 97 patients (71.9%), then trauma due to work accidents as many as 22 patients (16.3%), followed by thoracic trauma due to crime 9 patients (6.7%) and household accidents were 7 patients (5.2%). Hemothorax was the most common trauma with 57 patients (42.2%). Meanwhile, there were 41 cases of pneumothorax (30.4%), massive hemothorax 27 cases (20%) and 10 cases of tension pneumothorax (7.4%), with 110 patients (81.5%) were men and 25 patients (18.5%) were women.

Table. 1. Demography and distribution data of types, cause, characteristic, length of stay and mortality in thoracic trauma with primary chest tube insertion

Tracheobronchial Injury	
No	131 (97,0%)
Yes	4 (3,0%)
Extrathoracic Injury	
No	27 (20,0%)
Yes	108 (80,0%)

Chest Tube related infection	
No	133 (98,5%)
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Characteristics	Total (n = 135)
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Trauma Cause	
Traffic accidents	97 (71,9%)
Work accidents	22 (16,3%)
Household accidents	7 (5,2%)
Criminal	9 (6,7%)
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Types Trauma	
Pneumothorax	41 (30,4%)
Tension Pneumothorax	10 (7,4%)
Hemothorax	57 (42,2%)
Massive Hemothorax	27 (20%)
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Gender	
Men	110 (81,5%)
Woman	25 (18,5%)
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Age	
< 30 years old	43 (31,9%)
30 – 41 years old	31 (23%)
42 – 54 years old	36 (26,7%)
55 – 70 years old	20 (14,8%)
>70 years old	5 (3,7%)
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P/F Ratio	
>400 mmHg	43 (31,9%)
300 – 400 mmHg	44 (32,6%)
200 – 300 mmHg	30 (22,2%)
150 – 200 mmHg	7 (5,2%)
<150 mmHg	11 (8,1%)
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Rib Fracture	
0	31 (23,0 %)
1-3	46 (34,1%)
4-6 Unilateral	29 (21,5%)
>3 bilateral	5 (3,7%)
Flail Chest	24 (17,8%)
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Pulmonary Contusion	
No	103 (76,3%)
Yes	32 (23,7%)
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Subcutaneous Emphysema	
No	99 (73,3%)
Yes	36 (26,7%)
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Yes	2 (1,5%)
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Thoracotomy surgery	
No	96 (71,1%)
Yes	39 (28,9%)
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NICE / POSSUM Operative Severity	
No operation	48 (35,6%)
Minor	11 (8,1%)
Moderate	57 (42,2%)
Major	13 (9,6%)
Major plus	6 (4,4%)
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Length Of Stay	
1-5 days	31 (22,9%)
6-10 days	45 (33,3%)
>10 days	59 (43,7%)
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Mortality	
Survived	115 (85,2%)
Death	24 (17,8%)
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In this study, the youngest age was 9 years, who had a tension pneumothorax due to a traffic accident. Meanwhile, the oldest age was 90 years who had a pneumothorax due to a work accident. With most of the patients were under 30 years old (43 patients; 31.9%), 43-54 years old were 36 patients (26.7%), 30-41 years old were 31 patients (23%), age 55-70 years old were 20 patients (14.8%) and above 70 years old were 5 patients (3.7%).

Of the 135 patients, most of them had a P/F ratio between 300 – 400 mmHg, 44 patients (32.6%), 43 patients (31.9%) had a P/F ratio higher than 400 mmHg and 30 patients (22.2%) had a P/F ratio between 200 – 300 mmHg. A small proportion had a low P/F ratio, which was less than 150 mmHg in 11 patients (8.1%) and between 150-200 mmHg in 7 patients (5.2%).

A total of 46 patients (34.1%) had fractures in 1-3 ribs, while 31 patients (23%) had no rib fractures. A total of 29 patients (21.5%) had fractures in 4-6 unilateral ribs, 24 patients (17.8%) had flail chest, and a small proportion of 5 patients (3.7%) had fractures in more than 3 ribs that occurred bilaterally.

A total of 32 patients (23.7%) had pulmonary contusion, 8 patients (5.9%) had bilateral unilobar or unilateral bilobar contusions. A total of 2 patients (1.5%) had bilateral contusions of less than 2 lung lobes, and there was 1 patients (0.7%) who had bilateral contusions of more than 2 lung lobes.

There were 36 patients (26.7%) who had subcutaneous emphysema. Based on the presence or absence of tracheobronchial injury, only a small proportion (4 patients; 3%) had tracheobronchial injury, while the other 131 patients (97%) did not. Extrathoracic injuries were found in 108 patients (80%) and 27 patients (20%) had no extrathoracic injuries.

Table. 2. Characteristic distribution based on length of stay and mortality.

Characteristics	Length of stay			Mortality (n = 24)
	1-5 days	6-10 days	>10 days	
Trauma Cause				

Traffic accidents (n = 97)	19 (19,6%)	27 (27,8%)	51 (52,6%)	19 (19,6%)
Work accidents (n = 22)	6 (27,3%)	11 (50%)	5 (22,7%)	3 (13,6%)
Household accidents (n = 7)	3 (42,9%)	2 (28,6%)	2 (28,6%)	2 (28,6%)
Criminal (n = 9)	3 (33,3%)	5 (55,5%)	1 (11,1%)	0
<b>Types Trauma</b>				
Pneumothorax (n = 41)	13 (31,7%)	11 (26,8%)	17 (41,5%)	9 (21,9%)
Tension Pneumothorax (n = 10)	3 (30%)	3 (30%)	4 (40%)	3 (30%)
Hemothorax (n = 57)	10 (17,5%)	24 (42,1%)	23 (40,3%)	10 (17,5%)
Massive Hemothorax (n = 27)	5 (18,5%)	7 (25,9%)	15 (55,5%)	2 (7,4%)
<b>Gender</b>				
Men (n = 110)	23 (20,9%)	42 (38,2%)	45 (40,9%)	18 (16,4%)
Woman (n = 25)	8 (32%)	3 (12%)	14 (56%)	6 (24%)
<b>Age</b>				
< 30 years old (n = 43)	6 (13,9%)	15 (34,9%)	22 (51,2%)	7 (16,4%)
30 – 41 years old (n = 31)	5 (16,1%)	15 (48,4%)	11 (35,5%)	3 (9,7%)
42 – 54 years old (n = 36)	9 (25%)	10 (27,8%)	17 (47,2%)	5 (13,9%)
55 – 70 years old (n = 20)	8 (40%)	5 (25%)	7 (35%)	7 (35%)
>70 years old (n = 5)	3 (60%)	0	2 (40%)	2 (40%)
<b>P/F Ratio</b>				
>400 mmHg (n = 43)	9 (20,9%)	14 (32,5%)	20 (46,5%)	7 (16,3%)
300 – 300 mmHg (n = 44)	12 (27,3%)	16 (36,4%)	16 (36,4%)	6 (13,6%)
200 – 300 mmHg (n = 30)	6 (20%)	10 (33,3%)	14 (46,7%)	6 (20%)
150 – 200 mmHg (n = 7)	1 (14,3%)	2 (28,6%)	4 (57,1%)	3 (42,8%)
<150 mmHg (n = 11)	3 (27,3%)	3 (27,3%)	5 (45,4%)	2 (18,2%)
<b>Rib Fracture</b>				
0 (n = 31)	9 (29%)	9 (29%)	13 (41,9%)	4 (12,9%)
1-3 (n = 46)	12 (26,1%)	15 (32,6%)	19 (41,3%)	8 (17,4%)
4-6 Unilateral (n = 29)	4 (13,8%)	12 (41,4%)	13 (44,8%)	3 (10,3%)
>3 bilateral (n = 5)	0	1 (20%)	4 (80%)	0
Flail Chest (n = 24)	6 (25%)	8 (33,3%)	10 (41,7%)	9 (37,5%)
<b>Pulmonary Contusion</b>				
No (n = 103)	24 (23,3%)	34 (33%)	45 (43,7%)	15 (14,6%)
Yes (n = 32)	7 (21,8%)	11 (34,3%)	14 (43,7%)	8 (25%)
<b>Subcutaneous emphysema (n = 36)</b>				
	6 (16,7%)	14 (38,9%)	16 (44,4%)	6 (16,7%)
<b>Tracheobronchial injury (n = 4)</b>				
	1 (25%)	1 (25%)	2 (50%)	1 (25%)
<b>Extrathoracic injury (n = 108)</b>				
	23 (21,3%)	29 (26,8%)	56 (51,8%)	22 (20,4%)
			<b>(p = 0.007)</b>	
<b>Chest Tube related infection (n = 2)</b>				
	1 (50%)	1 (50%)	0	0
<b>Thoracotomy surgery (n = 39)</b>				
	8 (20,5%)	15 (38,5%)	16 (41%)	7 (17,9%)
<b>POSSUM/ P-POSSUM Operative Severity</b>				
No operation (n = 48)	16 (33,3%)	16 (33,3%)	16 (33,3%)	6 (12,5%)
Minor (n = 11)	1 (9,1%)	3 (27,3%)	7 (63,6%)	0
Moderate (n = 57)	9 (15,8%)	21 (36,8%)	27 (47,4%)	9 (15,8%)
Major (n = 13)	3 (23,1%)	4 (30,8%)	6 (46,1%)	4 (30,8%)
Major + (n = 6)	2 (33,3%)	1 (16,7%)	3 (50%)	5 (83,3%)
				<b>(p = 0.003)</b>

Table. 3. Characteristics of thoracic trauma patients with primary chest tube based on length of stay and mortality : Simple logistic regression analysis.

Characteristics	Prolonged length of stay (>10 days)	Mortality
Trauma cause	<b>OR 8.076, p = 0.004</b>	OR 1.143, p = 0.285
Types Trauma	OR 1.139, p = 0.403	<b>OR 2.192, p = 0.139</b>
Gender	<b>OR 1.854, p = 0.173</b>	OR 0.802, p = 0.370
Age	OR 0.774, p = 0.379	<b>OR 3.183, p = 0.074</b>

P/F Ratio	OR 0.097, p = 0.755	OR 0.869, p = 0.351
Rib Fracture	OR 0.151, p = 0.698	<b>OR 3.690, p = 0.55</b>
Pulmonary Contusion	OR 0.136, p = 0.712	<b>OR 1.973, p = 0.160</b>
Subcutaneous emphysema	OR 0.011, p = 0.917	OR 0.041, p = 0.839
Tracheobronchial injury	OR 0.066, p = 0.797	OR 0.145, p = 0.704
Extrathoracic injury	<b>OR 11.254, p = 0.001</b>	OR 2.263, p = 0.132
Chest Tube related infection	OR 0.000, p = 0.999	OR 0.000, p = 0.999
Thoracotomy	OR 0.160, p = 0.689	OR 0.001, p = 0.974
POSSUM/ P-POSSUM Operative Severity	<b>OR 1.654, p = 0.198</b>	<b>OR 8.901, p = 0.003</b>

A total of 96 patients (71.1%) did not require thoracotomy surgery. There were 39 (28.9%) patients requiring thoracotomy surgery. A total of 48 patients (35.6%) did not require other sequel surgery, but 57 patients (42.2%) required moderate surgery according to POSSUM/P-POSSUM, 13 patients (9.6%) required major surgery, 6 patients (4.4%) required major plus category surgery, and 11 (8.1%) patients required minor category surgery.

In this study, the length of stay of 1-5 days was 31 patients (22.9%), the length of stay of 6-10 days was 45 patients (33.3%) and the most length of stay was more than 10 days were 59 patients (43.7%). In this study, the mortality rate was 24 people (17.8%) (Table. 2).

In statistical analysis, several variables were found that had a significant relationship with length of stay and mortality. The relationship between extrathoracic injury and length of stay >10 days had an adjusted odds ratio (aOR) of 6.038 (p = 0.007) ( Table. 4). Meanwhile, the relationship between major + surgery criteria and mortality had an aOR of 36,484 (p = 0.003) (Table. 5) .

Karakteristik	Mortalitas
Trauma cause	OR 0.707, p = 0.154
Age	OR 1.299, p = 0.268
Rib Fractures	OR 1.250, p = 0.262
Pulmonary Contusion	OR 1.496, p = 0.208
POSSUM/ P-POSSUM Operative Severity	OR 1.845, p = 0.005
No operation	OR 0.000, p = 0.999
Minor	OR 0.000, p = 0.999
Moderate	OR 1.187, p = 0.772
Major	<b>OR 3.214, p = 0.143</b>
Major +	<b>OR 36.484, p = 0.003</b>

Table. 4. Types trauma, gender, extrathoracic injury, operative severity of thoracic trauma patients with primary chest tube in relation to length of stay : Multivariable logistic regression analysis

Table. 5. Trauma cause, age, rib fractures, pulmonary contusion, and operative severity of thoracic trauma

Characteristics	Prolonged length of stay (>10 days)
Types Trauma	OR 0.575, p = 0.064
Gender	OR 1.250, p = 0.639
Extrathoracic injury	<b>OR 6.038, p = 0.007</b>
POSSUM/ P-POSSUM Operative Severity	OR 1.035, p = 0.831
No operation	
Minor	
Moderate	
Major	
Major +	

patients with primary chest tube in relation to mortality :  
Multivariable logistic regression analysis

## DISCUSSION

Thoracic trauma, whether it occurs in traffic accidents, work accidents, household accidents, or criminal acts, has long been the leading cause of death, along with head trauma and abdominal trauma. Based on this study conducted at Dr. Soetomo Teaching Hospital Surabaya from June 2017 to October 2021, the most common cause of trauma was traffic accidents (n = 97/135), followed by work accidents (n = 22/135). The mortality rate was 24 patients (17.8%). Consistent with the data from National Basic Health Research of the Ministry of Health, that in 2018 the death toll from traffic accidents was 29,472 (26.98%), while in East Java alone, the incidence of thoracic trauma reached 189 cases annually. <sup>[5,14,15]</sup>

Of the 97 patients who had traffic accidents, 74 of them were male. The age group of patients can be said to be fairly evenly distributed, but the mortality rate is quite large in the age group of 55-70 years. According to researchers, this is because physical endurance is not as good as the younger age group.

Most patients' P/F Ratio values are still above 200mmHg (86.7%) and above 300mmHg (64.5%). After statistical analysis, the value of the P/F Ratio in this study was not statistically significant for both prediction of length of stay and mortality. There were a case of a man aged 30 years who had a traffic accident, who was admitted with a P/F Ratio of 74mmHg (accompanied by pneumothorax, tracheobronchial injury, unilateral 6th rib fracture, bilateral 2-lobed pulmonary contusion, subcutis emphysema, and tracheobronchial injury), however, the patient was able to return home alive after 14 days of hospitalization after costal clipping thoracotomy, direct closure of tracheobronchial tract. Prompt and appropriate patient management can save a patient's life. On contrary, there was a 44-year-old man with a traffic accident, admitted with a P/F Ratio of 497mmHg (accompanied by a pneumothorax without any other complications in the thorax, but had ruptured spleen and liver), died after 7 days of hospitalization.

The incidence of rib fractures was quite high (n = 104; 77%). This is quite reasonable considering that rib fractures often tear the underlying organs and lead to either a pneumothorax or hemothorax. According to the American College of Surgeons. Committee on Trauma, the ribs are indeed the most frequently traumatized component of the thoracic cavity. <sup>[15,16,17]</sup>

The incidence of pulmonary contusion was 32 (23.7%), and most were focused on only one lobe and one side (unilobar, unilateral) (n = 21; 15.6%). In pulmonary contusion, symptoms will disappear without complications in 3-7 days, but in severe cases it can cause hypoxia, dyspnea, tachypnea and tachycardia. The incidence of subcutaneous emphysema is 36 (26.7%). However, according to statistical analysis in this study, there was no significant relationship between rib fractures, pulmonary contusions, and subcutaneous emphysema with length of stay and mortality.<sup>[18]</sup>

In patients who were multitrauma and underwent surgery with major surgery criteria+ according to POSSUM/P-POSSUM (eg aortic-related procedures, abdominoperitoneal resection, liver or pancreatic resection) there was a significant association with mortality (aOR 36,484; p = 0.003). This is quite clear considering that thoracic trauma alone has become one of the most common causes of death, especially when combined with high risk surgical procedure. This has clinical implications that multitrauma patients undergoing complicated surgery should receive special attention in their care in order to reduce the possibility of mortality of these patients.<sup>[3,14,15]</sup>

The number of thoracotomy actions in all patients was 39 (28.9%), this is in accordance with previous research studies which said that operative intervention in thoracic trauma has a range between 10-30%.<sup>[15,19]</sup>

Extrathoracic injuries were high (n = 108; 80%), indicating that the majority of patients included in this study were multitrauma patients. Multitrauma patients require coordination and multidisciplinary treatment from various specialties quickly and accurately. Thoracic trauma patients with extrathoracic injuries had a significantly longer length of stay than isolated thoracic trauma patients (aOR 6.038; p = 0.007). The length of hospitalization is very likely due to both operative and non-operative treatment.<sup>[14]</sup>

## CONCLUSIONS

From this study it can be concluded that the most common causes of thoracic trauma (with primary chest tube insertion) in Dr. Soetomo Hospital Surabaya is a traffic accident, with men as the largest population.

This study found a significant relationship between extrathoracic injury and length of stay in thoracic trauma patients who underwent primary chest tube placement. A significant relationship was also found between sequel surgery and mortality in thoracic trauma patients who underwent primary chest tube insertion. The researcher supports further studies that use more patients, and for a longer period of time. In addition, the researchers realized that the parameters used (age, gender, initial PaO<sub>2</sub>/FiO<sub>2</sub> ratio, number of rib fractures, pulmonary contusion, subcutaneous emphysema, tracheobronchial injury, extrathoracic injury, chest tube related infection, and follow-up surgery) were still lacking. so that further research is expected to be able to use more parameters and represent the cause of the length of hospitalization and patient mortality.

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## Informed Consent Statement

Not applicable

### Ethical Approval

Not applicable

### Conflict of Interest

The authors declared no conflict if interest.

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