

**Research Article**

**An Investigation of the Relationship between Mortality  
and Echocardiographic Findings in Valve Re-Operation**

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**ABSTRACT**

**Aim:** Background: Redo-operation of valve is known to be a risky surgery, but the real outcome of patients undergoing redo valve surgery in the new era of technologic advances and increased experience for redo surgeries is unclear. **Methods:** In a cross-sectional study, we evaluated all patients who underwent valve re-operation in Tehran Heart Center between January 2014 and October 2017. Preoperative data as well as post-operative outcomes and complications were retrieved from patients' records or surgical database of Tehran Heart Center. **Results:** The study population included 240 patients (138 females and 102 males) whose mean age was 53 years. Out of 240, 235 patients underwent elective, 3 patients emergency, and 2 patients urgent operations. Hospital mortality rate was lower in patients underwent elective surgery (P value<0.05). Twenty-two patients (9.2%) had primary CABG operation which ultimately had a higher mortality rate. Patients who died after surgery were older than those who remained alive (P value<0.05). **Conclusion:** In this study, the relationship between hospital mortality and higher age, the surgical necessity, the primary CABG, BUN, the higher amounts of preoperative Cr, and postoperative complications (pneumonia, prolonged ventilation, gastrointestinal bleeding, renal failure, and the need for dialysis) were significant. There was a significant relationship between patients with recurrent Tricuspid, paravalvular leak and hospital mortality.

**Keywords:** Valve Re-Operation, Hospital Outcome, Hospital Mortality

**INTRODUCTION**

Heart valve diseases account for about 10% to 20% of heart disease. Although the risk of Rheumatic disease of the heart valves has recently declined in the United States and Europe, the calcific valve diseases associated with an increase in age are still constant (1). Since the first

advances in valve operation and valve replacement as well as the use of Artificial Valves in 1950, significant advances have been made in this type of surgery (2-4). Improvement in survival after the first valve surgical repair or replacement has been reported in many heart

surgery centers. Therefore, many patients are in need of a re-operation and even third-time treatment that significantly affects their survival. Despite the desirable effect on improving patients' functional capacity and cardiac manifestations, valve replacement surgery has been associated with an increase in mortality and morbidity rates compared to primary operation, mainly due to increased cross-clamping period, bleeding risk, and pulmonary hypertension. In 1980s the mortality rate resulting from valve re-operation was estimated at 9.4% for elective cases and 42% for emergency cases (5, 6). Recently, the reduction of mortality and morbidity rate resulting from valve re-operation has been remarkable which has been largely due to technological advances and increased experience with it. On the other hand, the reduction in surgical risks in patients undergoing valve-reoperation is mainly due to cardiac support and less need for blood transfusion.

The main purpose of the present study was to investigate the relationship between mortality and preoperative echocardiographic findings in patients undergoing valve re-operation in our center. The echocardiographic determinants of outcome would result in more appropriate risk-stratification and case selection for redo-operation and also it may affect our decision for using specific techniques or assist devices.

## **MATERIAL & METHODS**

This was a cross-sectional study including all patients underwent redo-valve operation between March 2014 and March 2017 at Tehran Heart Center, a tertiary care cardiovascular hospital affiliated to Tehran University of Medical Sciences (Tehran, Iran). We excluded patients whose information was incomplete in the file or incomplete surgical database.

By reviewing the Surgical Database of Tehran Heart Center as well as the records of patients admitted to Tehran Heart Center, demographic and baseline clinical characteristics of patients, risk factors for heart disease, surgical history, indicators during the surgery, duration of admission to the hospital and intensive units, as

well as in-hospital mortality and morbidity were retrieved.

Moreover, data on post-operative complications including the need for gastrostomy, gastrointestinal bleeding, lower limb infection, septicemia, deep sternal infection, urinary tract infection, coma within the first 24 hours, post-operative cerebrovascular accidents, the need to use inotrope during operation, the need to transfuse packed red blood cell during surgery, and ventricular dysfunction was also extracted.

## **Data analysis**

The results for quantitative variables were expressed as mean and standard deviation (mean  $\pm$  SD) and for qualitative variables as percentages. Comparison between quantitative variables was performed by ANOVA test or in the case of abnormal distribution by Kruskal-Wallis test. The comparison between qualitative variables was also done using Chi-square test or Fisher's exact test. Furthermore, correlation between quantitative variables was investigated using Pearson correlation coefficient and Spearman rank correlation. Statistical analysis was performed using SPSS software version 20. The significance level was considered as P value less than 0.05.

## **Ethical considerations**

The study was performed in accordance with the declaration of Helsinki and subsequent modifications and its protocol was approved by ethics committees of the Tehran Heart Center and Tehran University of Medical Sciences.

## **RESULTS**

The study consists of 240 patients, including 138 women and 102 men. The mean age of these people was  $53 \pm 14$  years. Patients undergone second cardiac surgery after an average 12 years (Percentile 25: 7 years; percentile 75: 22 years). Increased prosthetic valve gradient was the most common (27.1%) cause for redo-valve surgery followed by malfunction of mechanical valve (20.4%) and disorders of other valves (15.0%). Table 1 demonstrates the distribution of underlying causes of redo-valve operation in study patients.

**Table 1:** Distribution of underlying causes of redo-valve operation

	Frequency	Percent
Addvalve	36	15.0
Calcification(senile)	8	3.3
Degeneration of biological valve	34	14.2
Increased gradient	65	27.1
Paravalvular leak	25	10.4
Malfunction of mechanical valve	49	20.4
Reumatismal	11	4.6
Vegetation	9	3.8
Creatinine level before surgery	0.83	
Hemoglobin level before surgery	13.07	
Others	3	1.3
Total	240	100.0

Regarding the type of operation performed on patients, 235 patients (97.9%) were elective, 3 (1.3%) were emergency and 2 patients (0.8%) were urgently operated (Diagram 3).

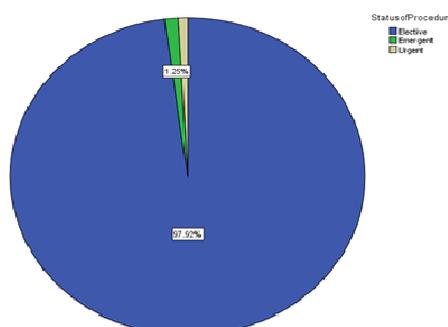


Diagram 3: Pie chart of the frequency of urgency of the surgery performed in the study.

Regarding the risk factors of patients, dyslipidemia (28.3%), hypertension (26.3%), cerebrovascular accidents (14.7%), diabetes (13.8%), chronic obstructive pulmonary disease (4.6%), infectious endocarditis (4.6%), Smoking (4.2%), renal failure (1.7%), and kidney failure requiring daily dialysis (1.3%) were respectively the most common risk factors in these patients. (Table 2).

Of the 240 patients examined, 22 patients (9.2%) had CABG primary operation, 206 patients (85.8%) had valve operation (repair or replacement) and 12 patients (5%) had CABG operation with valve operation (Table 3). In the case of pre-operative echocardiographic quantitative indicators, the data are presented in Table 5 (echo indicators are on the type of valve re-operation in the second operation).

Also, in relation to the qualitative indicators obtained from echocardiography, the data is presented in Table 6.

In the case of congestive heart failure, 8 patients (3.4%) had this failure before the secondary operation. Also, according to the NYHA functional classification, 17.5% of patients were classified in class I, 52.1% of patients in class II, 27.1% of patients in class III, and 3.3% of patients in class IV (Table 7).

The frequency of the secondary operation is as follows: 23 patients (9.6%) had CABG with valve operation, 6 patients (2.5%) with CABG operation and valvular operation accompanied by other surgeries, 140 patients (58.3%) valvular operation, and 71 patients (29.6%) had valvular operation accompanied by other surgeries (Table 8).

**Table 2:** Frequency of different risk factors in the patients

		Count	Column N %
<b>CVA</b>	No	203	85.30%
	Yes	35	14.70%
<b>COPD</b>	No	226	95.40%
	Yes	11	4.60%
<b>Diabetes</b>	No	207	86.30%
	Yes	33	13.80%
<b>Dyslipidemia</b>	No	172	71.70%
	Yes	68	28.30%
<b>Smoking</b>	No	227	95.80%
	Yes	10	4.20%
<b>Hypertension</b>	No	177	73.80%
	Yes	63	26.30%
<b>Infectious Endocarditis</b>	No	227	95.40%
	Yes	11	4.60%
<b>Renal Insufficiency (Dialysis Dependent)</b>	No	235	98.70%
	Yes	3	1.30%
<b>Renal Failure</b>	No	235	98.30%
	Yes	4	1.70%

**Table 3:** Frequency of the type of primary operation performed on patients

Primary Operation Category	Frequency	Percent
CABG	22	9.2
Valve	206	85.8
Valve+CABG	12	5.0
Total	240	100.0

**Table 4:** Frequency of valve type operated in re-operation procedure

	Frequency	Percent
Mitral	122	50.8
Aorta	79	32.9
Tricuspid	33	13.8
Pulmonary	6	2.5
Total	240	100.0

**Table 5:** The mean quantitative echocardiography parameters of patients under valve re-operation

	Mean	SD	Mean	SD	Mean	SD	Mean	SD
	tricuspid re-operation		tricuspid re-operation		pulmonary re-operation		Mitral re-operation	
RVD	31.44	5.883	37.44	10.589	49	4.050	32.33	5.280
TAPSE	16.65	3.572	16.55	4.486	16.67	3.141	16.46	3.375
EF	48.42	8.932	48.39	5.684	46.17	4.491	47.57	6.805
PAP	41.52	10.806	46.46	14.871	34.40	7.733	46.71	13.552
LA size	44.27	9.442	51.12	16.835	34	4.243	50.15	10.428
LVESD	36.57	8.348	33.82	7.939	30.33	3.445	35.75	8.420
LVEDD	53.23	8.666	49.64	7.877	43.33	2.733	51.97	8.840

**Table 6:** Frequency of echocardiographic qualitative parameters of patients underwent valve reoperation

	Frequency	Percent	Frequency	Percent	Frequency	Percent	Frequency	Percent
	tricuspid re-operation		pulmonary re-operation		Aorta re-operation		Mitral re-operation	
LVH	10		0	0	46	58.2	27	22.1
Paravalvular Leak	1		0	0	11	13.9	12	17.2
RVdysfunction	30		6	100	49	62	88	72.1
Diastolic Dysfunction	5		2	33.3	18	22.8	1	0.8
LA Size	N1	5	5	83.3	21	26.6	10	8.2
	Mild	11	1	16.7	29	36.7	32	26.2
	Moderate	3	0	0	12	15.2	31	25.4
	Severe	14	0	0	17	21.5	49	40.2
Vegetation	0		0	0	2	2.5	4	3.3

**Table 7:** Frequency of Congestive Heart Failure and NYHA Classification in Patients

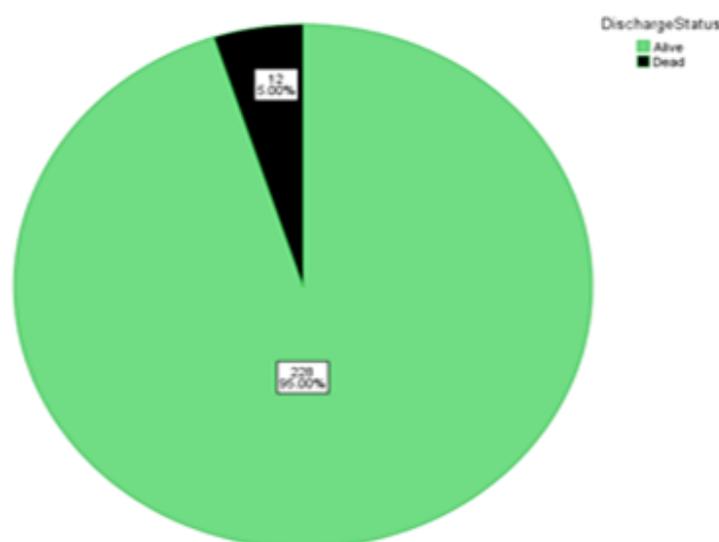
		Count	Column N %
<b>Preoperative Cardiac Status Congestive Heart Failure</b>	No	227	96.6%
	Yes	8	3.4%
<b>Preoperative Cardiac Status NYHA Classification</b>	I	42	17.5%
	II	125	52.1%
	III	65	27.1%
	IV	8	3.3%

**Table 8:** Frequency table of type of secondary operation of the patients

Secondary Operation Category	Frequency	Percent
CABG+Valve	23	9.6
CABG+Valve+Other	6	2.5
Valve	140	58.3
Valve+Other	71	29.6
<b>Total</b>	<b>240</b>	<b>100.0</b>

The hospitalization median of these patients in the ICU was 48 hours (25 percentile: 25 hours, 75 percentile: 88 hours), and the median of highest Cr level in these patients was 1.1 in ICU. (25 Percentile: 0.9; 75 percentile: 1.3).

Out of 240 hospitalized patients, 12 patients (5.0%) died and 228 patients, equivalent to 95%, were discharged (Figure 4).



**Diagram 4:** Pie chart of frequency of mortality in patients

2, 9, 0, and 1 patient who respectively underwent aortic, mitral, pulmonary, and tricuspid valve operation, died and no significant difference was found in the examination of the statistical tests (Table 9). Tricuspid valve: 33 patients in this study underwent tricuspid surgery that correlates their mortality with pre-operative echocardiographic quality indices. According to the table (10), there was a significant relationship between frequency of paravalvular leak in patients undergoing Tricuspid re-operation and mortality rate of these patients. There were no significant correlations between echo and mortality qualitative parameters. Also, there was no significant relationship between the means of quantitative echocardiographic parameters and the mortality rate in the patients undergoing tricuspid re-operation (Table 11).

Mitral valve: 122 patients in this study were under mitral valve operation. There was no significant relationship between the mortality rate and factors such as the size of the left atrium and left ventricular hypertrophy and other qualitative indicators of echo (Table 12).

Also, the mean of left ventricular diastolic and systolic diameters, left ventricular size and EF were not significantly different between dead and alive patients who underwent mitral valve operation (Table 13). Aortic valve: No significant correlation was found between the rate of mortality in the patients with aortic valve operation and different parameters in echocardiography (Tables 14 and 15). Pulmonary Valve: As there was no dead patient with pulmonary operation, a statistical analysis of the causes of death was not possible.

**Table 9:** Frequency of mortality in reoperations of each valve

			Discharge Status		Total
			Alive	Dead	
Valvetype	A	Count	77	2	79
		%	97.5%	2.5%	100.0%
M		Count	113	9	122
		%	92.6%	7.4%	100.0%
P		Count	6	0	6
		%	100.0%	0.0%	100.0%
T		Count	32	1	33
		%	97.0%	3.0%	100.0%
Total		Count	228	12	240
		%	95.0%	5.0%	100.0%

**Table 10:** Qualitative findings of echocardiographic and mortality in patients undergoing tricuspid re-operation.

		Discharge status		P value
		alive	dead	
Diastolic dysfunction	0	27 96.4%	1 3.6%	<b>1</b>
	1	5 100%	0 0%	
LA size	NL	5 100%	0 0%	<b>0.706</b>
	mild	11 100%	0 0%	
	moderate	3 100%	0 0%	
	severe	13 92.9%	1 7.1%	
LVH	0	22 95.77%	1 4.3%	<b>1</b>
	1	10 100%	0 0%	

Paravalvular leak	0	32	0	<b>0.03</b>
		100%	0%	
1	0	1		
	0%	100%		
RV dysfunction	0	3	0	<b>0.748</b>
		100%	0%	
	1	29	1	
96.7%		3.3%		
vegetation	0	32	1	
		97%	3%	

**Table 11:** Quantitative Echocardiographic Findings of mortality in Patients undergoing tricuspid re-operation

	Discharge Status	N	Mean	SD	P value
EF	Alive	32	48.66	5.568	0.136
	Dead	1	40.00	.	
PAP	Alive	28	46.46	14.871	
	Dead	0 <sup>a</sup>	.	.	
LA Size	Alive	32	51.00	17.090	0.819
	Dead	1	55.00	.	
LVED D	Alive	32	49.84	7.911	0.401
	Dead	1	43.00	.	
LVESD	Alive	32	33.94	8.036	0.633
	Dead	1	30.00	.	
RVD	Alive	32	37.44	10.589	
	Dead	0 <sup>a</sup>	.	.	
TAPSE	Alive	31	16.55	4.486	
	Dead	0 <sup>a</sup>	.	.	

**Table 12:** Qualitative echocardiographic findings of mortality in patients undergoing mitral re-operation

		alive	dead	<b>1</b>
Diastolic dysfunction	0	112	9	<b>0.774</b>
		92.6%	7.4%	
LA size	NL	1	0	<b>0.774</b>
		100%	0%	
	mild	9	1	
		90%	10%	
	moderate	29	3	
		90.6%	9.4%	
severe	30	1		
	96.8%	3.2%		
LVH	0	45	4	<b>1</b>
		91.8%	8.2%	
	1	88	7	
Paravalvular leak	0	92.6%	7.4%	<b>0.652</b>
		94	7	
	1	93.1%	6.9%	
		19	2	
RV dysfunction	0	90.5%	9.5%	<b>0.708</b>
		31	3	
	1	91.2%	8.8%	
82		6		
vegetation	0	93.2%	6.8%	<b>0.267</b>
		110	8	
	1	93.2%	6.8%	
	3	1		
	75%	25%		

**Table 13:** Quantitative echocardiographic findings of mortality in mitral valve re-operation patients

	Discharge Status	N	Mean	SD	P value
EF	Alive	113	47.83	6.603	0.126
	Dead	9	44.22	8.743	
PAP	Alive	105	46.66	13.822	0.885
	Dead	7	47.43	9.253	
LA Size	Alive	113	50.30	10.606	0.567
	Dead	9	48.22	8.090	
LVEDD	Alive	113	52.36	8.642	0.08
	Dead	9	47.00	10.320	
LVESD	Alive	113	35.91	8.414	0.444
	Dead	9	33.67	8.718	
RVD	Alive	113	32.35	4.993	0.847
	Dead	9	32.00	8.515	
TAPSE	Alive	107	16.57	3.376	0.206
	Dead	8	15.00	3.207	

**Table 14:** Quantitative Echocardiographic Findings × Mortality in patients undergoing aortic valve reoperation

	Discharge Status	N	Mean	SD	P value
EF	Alive	77	48.31	9.015	0.516
	Dead	2	52.50	3.536	
PAP	Alive	75	41.19	10.732	0.098
	Dead	2	54.00	5.657	
LA Size	Alive	77	44.26	9.565	0.972
	Dead	2	44.50	.707	
LVEDD	Alive	77	53.16	8.713	0.650
	Dead	2	56.00	8.485	
LVESD	Alive	77	36.56	8.443	0.942
	Dead	2	37.00	4.243	
RVD	Alive	77	31.38	5.865	0.537
	Dead	2	34.00	8.485	
TAPSE	Alive	76	16.63	3.592	0.706
	Dead	1	18.00	.	

**Table 15:** Qualitative echocardiography findings × Mortality in patients undergoing aortic valve reoperation

		Discharge status		P value
		alive	dead	
Diastolic dysfunction	0	60 98.4%	1 1.6%	<b>0.406</b>
	1	17 94.4%	1 5.6%	
LA size	NL	21 100%	0 0%	<b>0.316</b>
		27 93.1%	2 6.9%	
	mild	12 100%	0 0%	
		17 100%	0 0%	
	moderate	17 100%	0 0%	
		17 100%	0 0%	
LVH	0	32 97%	1 3%	<b>1</b>
		45 97.8%	1 2.2%	
	1	66 97.1%	2 2.9%	
		11 100%	0 0%	
Paravalvular leak	0	66 97.1%	2 2.9%	<b>0.565</b>
		11 100%	0 0%	
	1	66 97.1%	2 2.9%	
		11 100%	0 0%	

RV dysfunction	0	28	2	<b>0.141</b>
		93.3%	6.7%	
	1	49	0	
		100%	0%	
vegetation	0	75	2	<b>1</b>
		97.4%	2.6%	
	1	2	0	
		100%	0%	

## DISCUSSION

Most of previous studies have investigated patients undergoing reoperation of one of the valves, and only few studies evaluated the characteristics of re-operation procedures on all valves. In this study, given the low population size, descriptive statistics were more presented.

The second surgery was performed after an average of 15 years, which was significantly different from that of Tang et al. (10), which was 10.7 years.

Regarding the type of operation performed, of 240 patients, 235 patients were elective, 3 patients were emergent, and 2 patients were urgent. A small number of patients in emergency and urgent groups made it impossible to carry out analytical studies of these two groups. However, 97.9% of patients were elective and 2.1% were emergent or urgent.

In a study by Tang et al. (10) in Japan, all the patients who underwent valve re-operations on each of the valves consisted of 88% for elective cases and 12% for emergency cases or urgent, meaning that the number of emergency and urgent surgeries in the study was significantly more than our study. This may be due to mortality before they are admitted to the hospital, although in the same study, one of the main causes of hospital morbidity in the re-operation procedure is the urgency and emergency of the patients (P value = 0.009). Further studies with a larger population size must be carried out to confirm or reject the results.

The median duration of hospitalization in this study was 10 days, which is exactly the same as the median length of hospitalization in the study by Piehler et al.

During the study, out of 240 patients, 12 patients (5%) died during hospitalization. The hospital mortality rate in this study is lower than that in the study by Fukunaga et al. (2012), which is 6.7%. Also, the mortality rate during operation and the first month after re-operation in the study by Özyazıcıoğlu et al. (2012) was 8.2%. Also, it was 10.8% in the study by Piehler in 1995 on 1984 patients.

In this study, age, early CABG surgery, and higher levels of BUN and Cr before the operation were significantly associated with higher mortality rate after the operation. In the patients undergoing Tricuspid valve operation, paravalvular leak was associated with post-operative hospital mortality. In the study by Özyazıcıoğlu et al., it was found that the age factor in most patients had a significant and independent relationship with higher mortality rates. The study also found that patients who had undergone CABG during their primary operation had higher age and BMI, and lower intervals between two treatments. Also, these patients had more echocardiography, diastolic dysfunction, LVH, and mitral valve disorders (whether atherosclerosis or failure type).

Although patients undergoing CABG surgery in the second surgery or patients undergoing surgery as a result of endocarditis, patients undergoing emergency re-operation, diabetic patients, COPD, patients with infectious endocarditis, vegetation, less EF, more PAP in echocardiography and smoking record have been more commonly associated with death, however, in statistical tests, this difference was not significant. Also, there is a higher CHF and NYHA classification in patients with higher mortality rates, but this has not been statistically significant. However, this can be due

to the small size of the population. In a study by Tang et al. on 743 patients undergoing reoperation, COPD risk factor, congestive heart failure, higher NYHA class, and infectious endocarditis have been significantly associated with hospital mortality. In addition to the above, in the Tang study, the use of mechanical valves, peripheral vascular disease, cardiogenic shock, previous mitral valve surgery or mitral valve reoperation and urgency of the operation were also associated with more hospital mortality. Also, in multivariate analysis, urgency of the operation, shock, endocarditis, concurrent peripheral vascular disease and COPD were independently associated with hospital mortality.

In a univariate study by Fukunaga et al., the higher-grade NYHA class was associated with higher mortality. However, this issue has not been proven in multivariate analysis. In addition, in this study, the age above 70 and urgency and hemodialysis are also known as risk factors for hospital mortality.

## 6. CONCLUSION

This study was performed on 240 patients who had undergone valve re-operation during 2014 to 2017 in Tehran Heart Center Hospital. The relationship between different factors with hospital mortality was investigated and it was revealed that the age, urgency of the surgery, early CABG, higher BUN and Cr levels prior to surgery, pneumonia, prolonged ventilation, gastrointestinal bleeding, postoperative renal failure, and the need for post-operative dialysis are significantly related to the mortality. Also, in patients undergoing re-operation on tricuspid valve, the prevalence of paravalvular leak in preoperative echocardiography was associated with hospital mortality. The overall BMI of patients was higher than that of the normal population, but there was no significant difference between the two groups who died in terms of BMI. However, BMI, age, left ventricular hypertrophy, and diastolic dysfunction have been higher in patients undergoing previous CABG

surgery. Given the risk factors associated with mortality in patients, this study recommends a more accurate monitoring of patients with a higher age, history of previous CABG surgery, and higher BUN and Cr before surgery. It is also recommended that patients who have undergone pneumonia or long-term ventilation after reoperation or who need dialysis be given more attention.

Given that in this study, CABG secondary operation, secondary operation due to endocarditis, diabetes, COPD, infectious endocarditis record, vegetation, less EF, more PAP in echocardiography, and smoking were higher in dead patients, but it was not significant in the statistical test, it seems that in subsequent studies, the relationship between these factors and hospital mortality should be studied.

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