EFFECTIVENESS OF ACTIVATED CHARCOAL AND RESIN HEMOPERFUSION ON TREATMENT OF ACUTE PARAQUAT POISONING

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I. INTRODUCTION

In Vietnam, paraquat poisoning is common for its highly poisonous herbicide effect and cheap price. It can be lethal, and aggressive treatments might have little or no effect on severely poisnoned patients even with many methods of hemotriltration.

Recently, some study showed early hemoperfusion may improve survival of severely paraquat poisoned patients, particularly in those treated with repeated pulse therary [12, 13].

At Bach Mai Poison Control Center, paraquat poisoned patients are treated with all methods of detoxication including gastric lavage, activated charcoal, pulse therapy of methylprednisolone and cyclophophamide, other supportive treatment and early activated charcoal/resin hemoperfusion. The aim of this study was to investigate the differences in clinical outcomes between activated charcoald and resin hemoperfusion in the treatment of paraquat poisoning.

II. METHODS

2.1. Study Design

This was a retrospective observational controlled study. 62 cases treated by standard treatment in combination with hemoperfusion in 95 paraquat poisoning patients who were admitted to Bach Mai Poison Control Center during 12/2012 to 07/2013 were enrolled. Criteria for inclusion were suicide patients by paraquat ingestion and positive with paraquat in the urine.

Patients were categorized into 2 groups. Group 1 (Charcoal group) included 34 patients who were treated with activated charcoal hemoperfusion. Group 2 (Resin group) included 28 patients who were treated with resin hemoperfusion. Indication for stopping hemoperfusion was paraquat urine test was negative.

Severity score was evaluated by:

(1) Estimated paraquat ingestion based on asking paraquat drank and categorized into 3 groups: Group 1 (Mild): < 20 mg/kg; Group 2 (Average): 20-40 mg/kg; Group 3 (Severe): > 40 mg/kg.

(2) Urine paraquat concentration was categorized in to 3 grades: Grade 1 (Mild): < 20 µg/mL; Grade 2 (Average): 20-50 µg/mL; Grade 3 (Severe): > 50 µg/mL.

+ Death or alive patients was defined by telephone call. It was 2 months after treatment.

+ Indication for commencing hemoperfusion was: (1) patient ingested paraquat; (2) urine paraquat was positive. Hemoperfusion was performed as soon as possible. Indication for stopping hemoperfusion was: paraquat urine test was negative.

+ Paraquat urine concentration, whole blood count, basic hemocoagulation, ure, creatine, GOT, GPT, total bilirubin was tested before and after hemoperfusion.

+ Contraindication for hemoperfusion was: severe respiratory failure.

2.2. Study facilities

+ Fresenius Medical Care 4008S artificial renal machine with one time used hemoperfusion cartridge (HA230 resin hemoperfusion cartridge), rexeed L13 filter was connected after HA230 cartridge. Blood flow rate was 180 ml/min. The anticoagulant used was Lovenox.

+ Prismaflex (Gambro) machine with activated charcoal filter were used. Blood flow rate was 150-180 mL/min. The anticoagulant used was heparin.

+ Urine paraquat concentration was measure by phương pháp so quang.

2.3. Data analysis

Fischer Exact test was done for ratio comparison. Mann Whitney test and Sign test were done for comparison of percentage and continuous variables. Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA) was used for data analysis. $P<0.05$ was considered as significant.

III. RESULTS

3.1. General features of subjects before hemoperfusion

Table 3.1. General features

Characteristics	**Charcoal (n=34)** M ±SD (min-max)	**Resin (n=28)** M ±SD (min-max)	**p**	**All** M ±SD (min-max)
Age (years)	28,1±12,49 [14-79]	24,6±10,06 [11-48]	0,235	26,5±11,50[11-79]
Male/Female	16/18 (0,89)	12/16 (0,75)		28/34 (0,82)
Suicide	34	28		62
Time from ingestion to local hospital (h)	2,4±3,47 [0,5-21]	1,6±1,07 [0,5-4]	0,260	2,1±2,74 [0,5-21]
Time from ingestion to PPC (h)	8,5±6,72 [1-29]	7,1±8,79 [2-48]	0,475	7,8±7,69 [1-48]
Time from ingestion to first hemoperfusion (h)	11,8±6,39 [4,5-28,3]	12,4±9,93 [1,75-54]	0,793	12,1±8,14 [1,75-54]
Time from PCC to first hemoperfusion (h)	5,1±4,02 [1-20]	5,8±4,03 [1,75-18]	0,509	5,5±4,01 [1-20]
Estimated dose of paraquat ingested (mg/kg)	75,9±55,1 [20-300]	36,8±41,53 [2-200]	0,008	57,6±52,56 [2-300]
Urine paraquat concentration (µg/mL)	59,3±44,92 [1-100]	82,5±32,74 [0,01-100]	0,075	37,9±37,78 [0,01-100]

Times of hemoperfusion	1,3±0,68 [1-4]	2,5±1,29 [1-5]	0,001	1,9±1,17 [1-5]
Mortality (%)	25/31 (80,6%)	12/25 (48%)	0,011	31/56 (55,3%)

Note: There was 3 missing patients in both two group (charcoal and adsorba) because of there was not information about last result (death or alive).

Comment:

+ There were not any different about age, mal/female ratio, time from ingestion to local hospital, time from ingestion to PCC, time from ingestion to first hemoperfusion, urine paraquat concentration between two group.

+ Estimated dose of paraquat ingested in adsorba group was more than resin group significantly, but urine paraquat concentration was not different in two groups.

+ Times of resin hemoperfusion was more than activated charcoal hemoperfusion.

+ Mortality in resin group was lower than charcoal group significantly.

3.2. Clinical features

Bảng 3.2. Clinical features on admission

Characteristics	**Charcoal (n=34)** M ±SD (min-max)	**Resin (n=28)** M ±SD (min-max)	**p**	**All** M±SD (min-max)
Mouth and throat ache	23/34	20/28	0,788	43/62
Mouth and tongue ulcers	6/34	4/28	0,499	10/62
Pulse (l/ph)	89,4±16,29 [57-120]	89,7±13,56[66-120]	0,939	89,6±14,92 [57-120]
BP_S (mmHg)	113,6±12,39[90-140]	117,5±11,43 [100-150]	0,214	115,4±12,02 [90-150]
BP_D (mmHg)	69,4±12,48[30-100]	72,1±9,17 [60-90]	0,339	70,7±11,08 [30-100]
Glasgow	15	15		15
RR (l/ph)	22,1±6,32[16-35]	20,5±2,24 [18-25]	0,305	21,2±4,37 [16-25]
SpO2 (%)	98,4±1,39 [95-100]	97,4±1,73 [94-100]	0,051	97,9±1,63 [94-100]
Renal failure (%)	21/34 (61,8%)	11/28 (39,3%)	0,066	33/62
Liver injury (%)	10/34 (29,4%)	6/28 (21,4%)	0,338	16/62

Comment: There was not any different in clinical characteristics between two groups: mouth and throat ache, mouth and tongue ulcers, pulse, BP, RR, and SpO2. Renal failure rate in resin group had lower tendency than charcoal one (p=0,066).

3.3. Laboratory features

Table 3.3. Biochemistry features on admission

	Charcoal (n=34) M±SD (min-max)	**Resin (n=28)** M±SD (min-max)	**p**
Ure (mmol/l)	6,3±3,04 [1,8-16,4]	4,6±1,58[0,4-8,7]	0,009
Creatinin (μmol/l)	132,0±81,73 [31-324]	109,6±102,67 [28-600]	0,343
AST (IU/l)	30,6±22,27 [7-133]	24,9±14,70 [13-84]	0,251
ALT (IU/L)	20,8±14,36 [7-57]	17,7±8,55 [10-41]	0,312
Bilirubin TP (μmol/l)	12,5±10,49 [3,2-52,6]	12,8±4,58 [6,4-20,8]	0,911
Na (mEq/l)	136,7±4,37[130-149]	136,3±2,91[131-144]	0,762

K (mEq/l)	3,1±0,61 [2,2-4,4]	3,1±0,49 [2,1-4,4]	0,575

Comment: There was not different in biochemistry features on admission between two groups except for ure.

Table 3.4. Hematologic features on admission

Blood count	**Charcoal (n=34)** M ±SD (min-max)	**Resin (n=28)** M ±SD (min-max)	**p**
HC (T/l)	5,01±0,77 [3,32-6,59]	4,7±0,72 [2,27-6,09]	0,071
Hb (g/l)	142,7±19,91 [105-182]	138,7±16,78 [110-187]	0,399
HCT (l/l)	41,7±5,29 [30-52]	40,6±4,77 [33-51]	0,391
BC (G/l)	17,9±8,49 [4,4-34,7]	15,3±7,23 [5,8-33,2]	0,191
TC (T/L)	252,2±52,88 [178-387]	272,6±61,46 [149-393]	0,167

Comment: There was not any different in hematologic features on admission between two groups.

Table 3.5. Coagulation features on admission

Coagulation	**Charcoal (n=34)** M ±SD (min-max)	**Resin (n=28)** M ±SD (min-max)	**p**
PT%	81,8±12,09 [46-106]	83,0±10,33 [48,697,5]	0,674
INR	1,1±0,11 [0,97-1,46]	1,2±0,63 [1,01-4,4]	0,417
Fibrinogen (g/l)	2,1±0,71 [0,35-3,5]	2,1±0,43 [1,23-3,24]	0,924

Comment: There was not any different in coagulation features on admission between two groups.

Bảng 3.6. Features of blood gas on admission

Khí máu	**Charcoal (n=34)** M ±SD (min-max)	**Resin (n=28)** M ±SD (min-max)	**p**
pH	7,44	7,4±0,06	0,575
pO2 (mmHg)	101	106,4±34,55 [39-211]	0,879
pCO2 (mmHg)	36	35,7±8,19 [11-45]	0,968
HCO3(mmol/l)	24,5	22,8±5,4 [6,5-28,5]	0,765
Lactic (mmol/l)	1	3,6±3,74 [0,5-13,3]	0,608

Comment: There was not any different in blood gas between two groups on admission.

3.4. Effectiveness of two groups

Table 3.7. Progession of paraquat concentration in the urine before and after hemoperfusion

	Charcoal (n=34) M ±SD (min-max)	**Resin (n=28)** M ±SD (min-max)	**p**
Decrease in urine paraquat concentration after one procedure (µg/mL)	52,1±37,5 [2-99]	65,5±31,3 [9,5-99]	0,260
Rate of decreation of urine	79,9±21,95 [49-100]	87,1±17,26 [50-100]	0,294

paraquat concentration after one procedure (%)			
Duration of procedure (hrs)	4,4±1,16 [2-7]	4,3±0,67 [3,5-6]	0,637

Comment: There was not different in decrease in urine paraquat concentration after one procedure, decrease in urine paraquat concentration after one procedure and duration of procedure.

Table 3.8. Duration between two procedures

	Duration 1-2 (hours)	**Duration 2-3 (hours)**	**Duration 3-4 (hours)**	**Duration 4-5 (hours)**
Charcoal	19±7,52 [8-26]	18±7,07 [13-23]	25	
Resin	11,4±6,79 [3-23,5]	16,2±7,75 [6-27,3]	17,5±4,72[10-24]	20,5±2,12[19-22]
p	0,039	0,765	0,187	

Comment: Duration from the first to second procedure in resin group was shorter charcoal one.

Table 3.9. Hematologic and biochemistry characteristics before and after procedures

Characteristic	**Charcoal (n=34)** M ±SD (min-max)	**Resin (n=28)** M ±SD (min-max)	**p**
Platelets before procedure (G/L)	252,2±52,88 [178-387]	272,6±61,46 [149-393]	0,167
Platelets after procedure (G/L)	111,1±39,70 [31,1-214]	188,4±76,14 [77-332]	0,0001
Rate of decretion of platelets after first procedure (%)	53,6±14,37 [13-78]	31,9±20,53 [3-66]	0,0001
Ure before procedure	6,3±3,04 [1,8-16,4]	4,6±1,58 [0,4-8,7]	0,009
Ure after procedure	7,6±4,71 [1,6-21,1]	2,9±1,72 [0,9-8,5]	0,0001
Creatinine before procedure	132,0±81,73 [31-324]	109,6±102,67 [28-600]	0,343
Creatinine after procedure	111,4±59,91 [37-237]	81,0±34,17 [35-165]	0,029
GPT before procedure	20,8±14,36 [7-57]	17,7±8,55 [10-41]	0,312
GPT after procedure	47,3±79,12 [6-310]	55,9±77,07 [10-256]	0,711
BilTP before procedure	12,5±10,49 [3,2-52,6]	12,8±4,58 [6,4-20,8]	0,911
BilTP after procedure	19,7±11,41	20,7±11,01	0,86

	[10,5-40,5]	[5,3-44,2]	
Na before procedure	138,4±4,27 [123-145]	138,4±3,61 [130-145]	0,948
Na after procedure	136,7±4,37 [130-149]	136,3±2,91 [131-144]	0,762
K before procedure	3,1±0,61 [2,2-4,4]	3,1±0,49 [2,1-4,4]	0,575
K after procedure	3,6±0,60 [2,9-6]	3,1±0,39 [2-3,7]	0,001

Comment: There was a decreased platelete count after hemoperfusion in two groups. After the first procedure, ure and creatinin decreased significantly in resin grou and platelet count decreased significantly in charcoal group.

Table 3.10. Some characteristics in death patient group on admission

Characteristics	**Charcoal (n=25)** M±SD (min-max)	**Resin (n=12)** M±SD (min-max)	**p**
Estimated paraquat ingestion (mg/kg)	88,3±56,92 [20-300]	60,0±57,88 [10-200]	0,229
Urine paraquat concentration (µg/dl)	68,6±45,49 [1-100]	100	0,033
Ure (mmol/l)	7,05±2,96 [4,1-16,4]	4,8±1,77 [0,4-8,3]	0,023
Creatinin (µmol/l)	150,5±79,67 [34-324]	153,7±146,91 [28-600]	0,933
ALT (IU/l)	23,7±15,38 [9-57]	18,9±9,34 [10-41]	0,331
Bạch cầu (G/L)	21,2±7,5 [8,3-34,7]	18,2±6,74 [10,4-32,9]	0,261

Comment: In death patient group, estimated paraquat ingestion, urine paraquat concentration were both in severe group.

Table 3.11. Some characteristics in alive patient group on admission

Characteristics	**Charcoal (n=6)** M±SD (min-max)	**Resin (n=13)** M±SD (min-max)	**P**
Estimated paraquat ingestion (mg/kg)	30±14,14 [20-50]	21,5±14,56 [2-50]	0,335
Urine paraquat concentration (µg/dl)	25±22,91 [5-50]	65±39,65 [0,01-100]	0,123
Ure (mmol/l)	3,2±1,06	4,4±1,52	0,111

	[1,8-4,5]	[3,1-8,7]	
Creatinin (µmol/l)	59,0±19,61 [31-88]	78,8±22,36 [51-139]	0,08
ALT (IU/l)	12,5±7,79 [7-28]	17,3±8,7 [10-39]	0,265
WBC (G/l)	9,5±3,89 [4,4-14,2]	13,6±7,58 [5,8-33,2]	0,237
CO2	36	39,2±4,5 [27-45]	0,513
HCO3	24,5	24,7±3,5 [14,3-28,5]	0,954
Lactate	1,6	2,0±2,53 [0,5-10,2]	0,879
Times of procedure	1,7±1,21 [1-4]	2,2±0,93 [1-4]	0,277
Duration of procedure (hrs)	4,9±0,95 [4-6]	4,4±0,71 [3,5-6]	0,217

Comment: There were not any different in estimated paraquat ingestion, urine paraquat concentration, ure, creatinin, ALT, WBC, CO2, HCO3, Lactate in alive patients in both group.

Table 3.12 – Some characteristics in 13 alive patients in resin group

Patients	**Estimated paraquat ingestion**	**Urine paraquat concentration (µg/mL)**	**Duration of procedure (hrs)**	**Times of procedure**	**Ure/ Creatinin**	**WBC (G/L)**
Patient 1	*	0,01	10	1	3,2/61	
Patient 2	40	50	9,5	2	3,4/80	9,4
Patient 3	50	100	22	1	4/59	21,06
Patient 4	10	100	5,5	3	4,2/70	7,07
Patient 5	20	10	11	2	4,9/89	11,52
Patient 6	20	20	7	2	3,1/51	7,29
Patient 7	*	100	5,5	3	4,8/98	33,2
Patient 8	30	100	1,75	2	4/69	9,87
Patient 9	2	100	7	3	3,1/69	12,32
Patient 10	15	50	18	1	3,6/79	5,78
Patient 11	10	50	27	4	8,7/89	16,69
Patient 12	10	0,2	54	2	5,9/139	20,22
Patient 13	30	20	20	3	4,1/72	11,95

BN 1 and 7: no information about estimated paraquat ingestion.

3.5. Characteristic and prognostic factors

Table 3.13. Characteristics and prognostic factors on admission

Characteristics	**Alive (n=19)** M ±SD (min-max)	**Death (n=37)** M ±SD (min-max)	**p**
Ure (mmol/l)	4,0±1,48 [1,8-8,7]	6,3±2,81	0,001
Creatinin (µmol/l)	72,6±23,02 [31-139]	151,5±104,06 [28-600]	0,002
ALT (UI/L)	15,8±8,52 [7-39]	22,1±13,76 [9-57]	0,072
WBC G/L)	12,3±6,80 [4,39-33,2]	20,2±7,31 [8,29-34,7]	0,001
PT%	82,3±7,69 [68,9-95,8]	83,1±13,23 [46-106]	0,814
pH	7,4±0,05 [7,25-7,46]	7,4±0,07 [7,31-7,6]	0,753
pCO2	38,9±4,41 [27-45]	31,6±9,98 [11-42]	0,02
pO2	96,5±16,15 [76-144]	120,0±46,35 [39-211	0,088
HCO3	24,7±3,38 [14,3-28,5]	20,5±6,59 [6,5-28,5]	0,045
Lactat	1,99±2,43 [0,5-10,2]	5,5±4,29 [0,7-13,3]	0,016
Estimated paraquat ingestion (mg/kg)	23,8±14,47 [2-50]	79,5±57,7 [10-300]	0,001
Urine paraquat concentration (µg/dL)	57,0±39,81 [0,01-100]	84,3±35,25 [1-100]	0,035
Time from ingestion to local hospital (hrs)	1,7±1,13 [0,5-5]	1,7±1,13 [0,5-5]	0,506
Time from ingestion to PCC (hrs)	10,2±10,56 [2,5-48]	6,7±5,79 [1-29]	0,113
Time from ingestion to first hemoperfusion (hrs)	6,3±5,4 [1-20]	5,1±3,26 [1-14]	0,34
Time from ingestion to hemoperfusion (hrs)	14,9±11,96 [1,75-54]	10,6±5,30 [4,5-28,3]	0,067
Mouth ulcers	6/19	4/37	0,063

Comment: In death patient group, there was renal failure, acidosis, lactate increase, estimated paraquat ingestion and urine paraquat concentration was high.

Table 3.14. Degree of severity according to estimated dose of paraquat ingestion

Estimated paraquat ingestion	***Death n (%)***	***Alive n (%)***	***All n (%)***
Mild: <20 mg/kg	2 (18,2%)	9 (81,8%)	11 (100%)
Average: 20-40 mg/kg	5 (55,6%)	4 (44,4%)	9 (100%)
Severe: >40 mg/kg	22 (91,7%)	2 (8,3%)	24 (100%)

IV. DISCUSSION

4.1. General characteristic features

Age and sex: In the study, mean age was 26,5±11,50 [11-79], male patients accounted for 45,1% of the cases, this rate in Hung HT was 52,6% [3]; Thang VD., 53,3% [2], Duong LK. 43,5% [4]. It seemed there was no difference of gender in paraquat poisoning.

Causes of poisoning: All patients were suicide.

Times: Studies showed that the most effective time for hemoperfusion for paraquat poisoning patients was during 4-6 hrs from ingestion (The paraquat concentration in blood was highest but not saturated in lung tissue) [1]. Yoon et al showed that paraquat was saturated in lung was at 15 hours, and hemoperfusion must be carried out during this time [5].

In the study, the average time from ingestion to the local hospital was 2,1 ±2,74 h, it was golden time for hemoperfusion for paraquat elimination. The average time from ingestion to first hemoperfusion was 12,1±8,14 hrs shorter in the study of Chinh ND. (15±14,4 hrs) and similar to the study of Thang VD (~ 11 hrs). This time in study of Duong LK was in the 6 hrs of ingestion (90,5% - 19/21 patients).

In the rescued patient group that had urine paraquat concentration above 100µg/ml, hemoperfusion was perform for 4/5 patients soon, it was before 7th hrs.

4.2. Effectiveness of hemoperfusion

In the study, 1,3±0,68 [1-4] times of activated charcoal was applied, it was significantly shorter than resin hemoperfusin group with 2,5±1,29 [1-5] times

The change of urine paraquat concentration in the first time of hemoperfusion

Studies thought that the first hemoperfusion was most important, because it helped quickly to eliminate paraquat in blood, diminishing influence of paraquat to the organs such as lung, liver and renal, reducing mortality [1].

Due to not to determine amount of paraquat in the blood, urine paraquat concentration was estimated by semi-quantitative method for evaluating effectiveness of hemoperfusion.

Table 3.7 showed urine paraquat concentration decreased 52,1±37,5 (µg/mL) in activated charcoal hemoperfusion and 65,5±31,3 (µg/mL) in resin group (p=0,260). The rate of decreation of urine paraquat concentration after first procedure was 79,9±21,95 (%) in charcoal group and 87,1±17,26 (%) in resin group (p=0,294).

Some following studies showed the effectiveness of hemoperfusion. [1], [2], [4]:

Table 4.1 Comparison in some studies about hemoperfusion

Studies	**n**	**Urine paraquat concentration before first HP (µg/mL)**	**Urine paraquat concentration after first HP (µg/mL)**	**Mean time of HP**	**Mortality**
V.Đ.Thắng (2012)	27	385	60	3,4±2,1 [1-9]	17/27 (62,9%)
Phạm Duệ (2012)	19	165,5±353,22	30,2	2,53 [1-5]	15/19 (78,9%)
L.K. Dương (2013) HA230	21				13/21 (61,9%)
This study	62	37,9±37,78 [0,01-100]	12,6±19,39 [0,2-50]	1,9±1,17 [1-5]	31/56 (55,3%)
Charcoal	31	59,3±44,92 [1-100]	1,8±2,75 [0-5]	1,3±0,68 [1-4]	25/31 (80,6%)
Resin	25	82,5±32,74 [0,01-100]	16,2±27,8 [0-50]	2,5±1,29 [1-5]	12/25 (48%)

This table showed mortality in the study was lower than others. Mortality in the resin was lowest (48%).

Effectiveness of hemoperfusion according to new methods:

Efftectiveness of one time hemoperfusion was not different between charcoal and resin, but the last outcome showed the mortality of resin group was lower than charcoal one.

+ *Time and duration between every time of hemoperfusion:* In comparison with charcoal group, resin group was improved by shortening duration between every time of hemoperfusion in order to quickly eliminate paraquat in the blood but not cause complication for the patients such as: bleeding due to thrombocytopnenia. Table 3.8 showed duration between every time of hemoperfusion was significantly shorten 11,4±6,79 hrs (resin group) and 19±7,52 hrs (charcoal group). With no difference of duration for one time of procedure (Table 3.7), we thought it was shorted duration between every time of hemoperfusion that helped to quickly eliminate paraquat concentration in the blood in order to reduce mortality.

+ *Method of hemoperfusion:* There were many methods of hemoperfusion. In the study, activated charcoal filter was directly connected to the blood stream through the femoral vein; in resin hemoperfusion, the blood stream went through resin filter for absorption then to the artificial kidney filter for dialyzing before to the body. Table 3.9

showed ure and creatinine decreased significantly in resin group than charcoal one. And it was artificial kidney filter that helped to improve renal failure in resin group.

+ ***Complications:*** One of the common complications during hemoperfusion was decrease of platelets. Table 3.9 showed the rate of decretion of platelets after first procedure in resin group was lower than charcoal group (31,9% vs 53,9%). In the Chinh ND. study, this rate was 24-31% [1].

+ ***Other characteristics:***

* In the death group, there was no difference about estimated dose of paraquat ingestion between two groups, but urine paraquat concentration in resin group was significantly higher in charcoal group (all > 100 µg/mL). The times of procedures were more, duration between each time of dialysis was shorter, but the outcome was still severe.

Because death from resin group had 100% patients that had urine paraquat concentration abover 100 µg/mL, we suggested that hemoperfusion should be sooner applied for these patients, shortening duration between each times of procedure, or using other methods of dialysis in order to rescue patients in border line severe degree of poisoning. In this aspect, some studies recommended dialyze methods right after hemoperfusion [6-8].

* In alive patient group, there was no difference between two groups of hemoperfusion about: estimated dose of paraquat ingestion, urine paraquat concentration, ure, creatinin, ALT, blood gas and times of procedures (Table 3.11).

In details of each patients, 5/13 patients who had urine paraquat concentration above 100 µg/mL were rescued. In these patients, 3 times of hemoperfusion was applied for 3/5 patients, 3 was soon perfomed during 7 hrs from ingestion (Table 3.12). In comparison with Chinh ND study, 4/19 (21%) patients was rescued with urine paraquat concentration 2-30 µg/mL in 5, 8, 11 and 46th hours after ingestion, in correlative times of hemoperfusion 2-5-1-2 in turn [1]. In these study, number of rescued patients was mor severe with higher of urine paraquat concentration. And it was shortening duration between each hemoperfusion that helped to save patient life.

4.3. Some factor of prognosis

+ ***Acute renal failure:*** patients with acute renal failure with increasing rate of creatinin < 3µmol/h was alive, and with > 4,3 µmol/h during 6 hrs was severe prognosis. In this study, creatinin was not measured for each 6 hours, but patients with renal failure on admission had poorer prognosis than non-renal failure group significantly.

+ ***Lactate:*** Higher lactate was poor prognosis. In one study, 222 paraquat poisoning patients, latate > 4,4 mmol/l, was high rate of mortality with 82% sensitivity and 88 specificity [9]. In our study, in death group, lactate was in 5,5±4,29 [0,7-13,3] mmol/L higher alive group significantly.

+ ***Urine paraquat concentration:*** In one study, 233 patients was on admission in about 12 hrs after ingestion; negative urine paraquat, 100% alive; positive urine paraquat,

40% died [11]. In 57 patients, urine paraquat < 1mg/L, there was no death, urine paraquat > 1 mg/L, mortality was high [10].

V. CONCLUSION

Resin hemoperfusion was effective in paraquat poisoning: rapidly reducing urine paraquat concentration, improving renal function, mortality 48%.

Some factor of prognosis: renal failure, lactate, estimated dose of paraquat ingestion, urine paraquat concentration.

VI. RECOMMENDATION:

Hemoperfusion should carried out in local hospital in order to sooner perform for the patients.

Duration between each time of hemoperfusion should be shorten in order to increase effective and reducing complication especially thrombocytopenia.

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