

Letter to the Editor

Analysis of Paraquat Intoxication Epidemic (2002-2011) within China\*

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Paraquat, is a Bipy herbicide have been widely used in last decade in China. Because of its high human toxicity and mortality characteristics, paraquat has been gained considerable attention in recent years. In order to evaluate the epidemic status of paraquat harm to human health in China, 24 h hotline information about paraquat intoxication consultation from January 1<sup>st</sup>, 2002 to December 31<sup>st</sup>, 2011 was collected by experienced practitioners in the Poison Control Center (National Poison Control Center, NPCC) of National Institute of Occupational Health and Poison Control of Chinese Center for Disease Control and Prevention, including profession, age, gender, time and dose of paraquat exposed, cause, contact method, time and symptom(s) in the first treatment, treatment procedure, cure situation and current condition.

Each paraquat intoxication case was followed-up once at lease by phone for prognosis information, including recovery status, such as improvement, aggravation, death and hospital transfer. "Improvement" indicates that the illness remits compared with that of last consultation or return visit; "aggravation" refers to the illness worsening in comparison with that of last consultation or return visit; "loss follow up" refers to respondent's refused or wrong phone number; and "unknown" refer to unclear or in determinate outcomes. The last two prognoses become the loss to follow up or unknown in return visits.

Data was analyzed by using SPSS 18.0 for Windows.

From 2002 to 2011, NPCC recorded 1571 cases of paraquat intoxication consultation in total, of which 27.88% (the largest ratio) were occurred in 2010 and 23.62% in 2011. Figure 1A showed that a rising tendency was presented during 2002-2010, with an annual average increasing rate of 47.35%. The most significant increasing rate occurred in 2010, with an increase by 247.62% over 2009 and 194.44% in 2011 as compared with 2009. Figure 1B showed that paraquat intoxication cases occurred all year around,

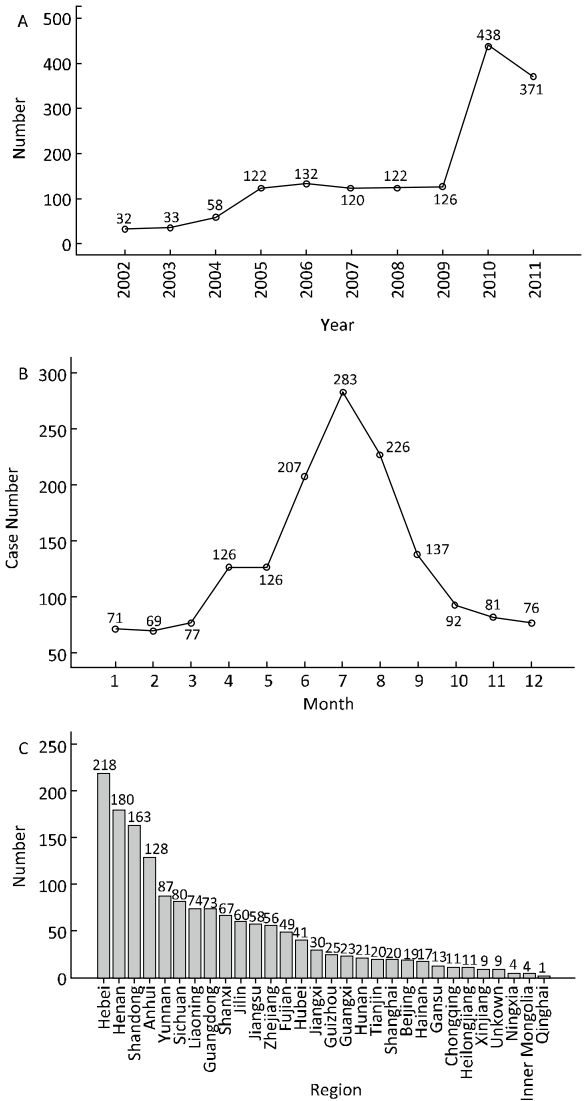


Figure 1. A: National paraquat intoxication status (2002-2011); B: Seasonal distribution of national paraquat intoxications (2002-2011). C: Regional distribution of national paraquat intoxications (2002-2011). Note: The "unknown" means that the consultants are unwilling to tell the location.

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and 45.58% (716/1571) occurred in summer (June, July, and August), 13.75% (216/1571) occurred in winter (December, January, and February). Figure 1C showed that paraquat intoxication cases occurred in 30 provinces, cities and municipalities in China apart from Hong Kong, Macao, Taiwan, and Tibet, of which 49.40% (776/1571) predominantly located in Hebei, Henan, Shandong, Anhui, and Yunnan, 1.15% (18/1571) located in Xinjiang, Qinghai, Ningxia and Inner Mongolia.

Table 1 shows that paraquat intoxication occurred at all age levels, the ratio of male to female was 46.47/49.14, of which 79.89% located at the age level 18-64, and 14.06% occurred at the age under 18. The youngest reported case was an individual aged 10 years old in the self-taking category, where 13.74% were under 18 years old and 83.84% were above 18 years old. Among the accidental ingestion cases, 52 (43.33%) were under 18 years old and 61 (50.83%) were above 18 years old.

Table 2 shows that 73.65% of the total number of intoxication cases resulted in suicide, 13.56% by occupational exposure, and 12.48% by accidental ingestion or accidental exposure.

Oral administration (81.29%) was the main contact access to paraquat. In addition, the occupational intoxications were mainly caused by skin and mucosa contact or respiratory tract inhalation.

Table 3 shows that there were total 824 cases of paraquat intoxication being followed from 2008 to 2011, of which 24.03% were death, 21.12% recovered and 28.88% lost to follow up, and fatality rate was 38.08%. Self-taking was the main cause lead to death.

The data we collected also showed that the maximum doses by self-taking were about 450-500 mL, while 50-60 mL by accidental ingestion, near half of the consultants (40.36%) responded they contact dose of 10-50 mL.

Results in our study showed that paraquat intoxication occurred in China growth rapidly and was widely distributed. Fatality rate remained at a higher level in the most last 10 years, particularly majority located at agricultural provinces. Poisoning cases most occurred via self-administration, followed by accidental consumption involving children, and lastly by occupational exposure without improper protection.

**Table 1.** Causes and Age Distribution of National Paraquat Intoxications (2002-2011)

Age	N (%)	Self-taking	Occupational Contact	Accidental Ingestion	Accidental Contact	Misuse
0-1	4 (0.25)	0	0	4	0	0
1-14	97 (6.17)	48	0	40	9	0
14-18	120 (7.64)	111	1	8	0	0
18-64	1255 (79.89)	935	201	54	60	5
64-	49 (3.12)	35	7	7	0	0
Unknown	46 (2.93)	28	4	7	7	0
Total	1571 (100.00)	1157	213	120	76	5

**Table 2.** Causes and Contact Access of National Paraquat Intoxications (2002-2011)

Causes	Number	Oral Administration	Percutaneous & Mucosa Contact	Respiratory Tract Inhalation
	Total (%)	N (%)	N (%)	N (%)
Self-taking	1157 (73.65)	1157 (90.60)	0 (0.00)	0 (0.00)
Occupational Contact	213 (13.56)	0 (0.000)	164 (68.05)	49 (92.45)
Accidental Ingestion	120 (7.640)	120 (9.40)	0 (0.00)	0 (0.00)
Accidental Contact	76 (4.84)	0 (0.000)	72 (29.88)	4 (7.55)
Misuse	5 (0.32)	0 (0.000)	5 (2.07)	0 (0.00)
Total	1571 (100.00)	1277 (100.00)	241 (100.000)	53 (100.00)
Ratio (%)	/	81.29	15.34	3.37

**Table 3.** Case Outcomes of National Paraquat Intoxications (2008-2011)

Return Visit Result	Total	Ratio (%)	Self-taking	Occupational Contact	Accidental Ingestion	Accidental Contact	Misuse
Death	198	24.03	192	0	5	0	1
Recovery	174	21.12	100	41	24	9	0
Improvement	107	12.99	82	20	3	2	0
Hospital Transfer	27	3.28	27	0	0	0	0
Aggravation	14	1.70	14	0	0	0	0
Unknown	66	8.01	51	11	2	2	0
Loss to Follow up	238	28.88	183	30	14	10	2
Total	824	100.00	649	102	48	24	3
Case Fatality Rate (%) <sup>*</sup>	38.08	/	46.27	0.00	15.63	8.33	100.00

**Note.** <sup>\*</sup>Case fatality rate (%) = Mortality / (Death + Recovery + Improvement + Hospital transfer + Aggravation) \* 100%.

Fatality rate in our study (38.08%) was consistent with other reports which were nearly 31.0%-97%<sup>[1-5]</sup>.

The main reasons that paraquat use and exposure were as following:

1. Production of paraquat has increased rapidly, with sales and usage widespread in many provinces over the past decade, especially recent 5 years. According to the Institute for the Control of Agrochemicals, Ministry of Agriculture (ICAMA 2004), there are only 76 registered paraquat products including 17 expired registrations for paraquat related products. Production increased rapidly to 524 till 2009<sup>[6]</sup>, growth of 589.47%, and does not include non-registered products. Therefore, as exposure opportunity increased, it is easy for individuals access to lethal dosages.

2. The publicity and promotion of paraquat is not enough. Compared to the widespread use of paraquat, public comprehension of the hazards surrounding paraquat remains insufficient. Many people misunderstood paraquat as a less-toxic herbicide. Regarding paraquat management, problems exist in the process of use and storage, the lack of safe keeping store counters, casual disposal of packaging after use or improper cap applications for liquids resulting in loose fittings and infant/child accidental contact. As a domestic industry, there remains insufficient worker protection within the production process, resulting in greater frequency of occupational poisoning that could lead to poisoning and even death. In the initial phase of the oral ingestion of paraquat, among numbers of patients, the commonly symptoms such as nausea and vomiting were often ignored and finally lead to

paraquat intoxication.

3. Medical staff in rural most often had little knowledge of harm and treatment of paraquat intoxication. In our investigation, many rural medical staff thought that paraquat is a less-toxic drug just as other herbicides, therefore, only gastric lavage or fluid infusion was implemented; extraordinary treatment protocols were often beyond their individual knowledge background. There is no specific antidote for paraquat until now. The symptoms such as multiple organ failure, acute lung injury, and pulmonary fibrosis are the most hazards to health at present. Although increasing papers about paraquat poisoning treatment were been published, but the case fatality rate still remain high.

From 2004, paraquat products standards require emetic odorant agent and chromogenic agent added to any paraquat solution, in order to achieve instant sensory awareness and reduced accidental oral consumption<sup>[7]</sup>. But this method has minimal effect on the suicidal cases based on our investigation. Regardless of the odorant, suicides will consume large doses, although after oral vomiting, there remains a significant residue of paraquat in the body, resulting in damage or even death. Up to date, more than 30 countries have stringent regulations for the safe management of paraquat<sup>[8]</sup>. China's current production of paraquat is about 24 000 tons, in China, and 18 000 tons inport in 2010. Therefore, we must face these security problems<sup>[9]</sup>. In June 2012, ICAMA declare that the organization will suspend the applications for registration of mothersolution and water solution of paraquat. ICAMA will also

demand of manufacturers to change the package labels, words "This product has no special antidote, it is a hyper-toxic and fatal drug" be required. The products bearing old label information will be forbidden from Dec. 31, 2013. The products with new label nomenclature will be forbidden from July. 1, 2016<sup>[10]</sup>.

Author's recommendations: (1) promotes the knowledge and increase publicity of paraquat toxicology, protection and self-rescue to social individuals. If exposure contact with paraquat occurs, washing and emetic as quickly as possible, then go to see a doctor. (2) The medical and health departments should intensify the treatment training of paraquat intoxication for the elementary medical personnel to reduce the case fatality rate by early diagnosing, early eliminating the toxicant effectively with comprehensive and positive treatment. (3) The regulatory authorities should enhance the supervision of paraquat's quality and put the safety precautions into practice. (4) Reinforce the development of alternative product of paraquat and new dosage of paraquat. Strengthen the risk assessment of paraquat.

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