© Med Sci Monit, 2011; 17(9): CS109-111
PMID: 21873952

www.MedSciMonit.com
Case Study

CS

Received: 2010.10.11
Accepted: 2010.11.12
Published: 2011.09.01

Whole blood transfusion in the treatment of an acute organophosphorus poisoning – a case report

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Data Interpretation
E Manuscript Preparation
F Literature Search
G Funds Collection

Stan Ryniak[1ABEF], Piotr Harbut[2BDEF], Waldemar Goździk[3DF], Janusz Sokołowski[4DF], Przemysław Paciorek[5DF], Joanna Hałas[5DF]

[1] Department of Anaesthesiology and Intensive Therapy, Karolinska University Hospital, Stockholm, Sweden
[2] Department of Anaesthesiology and Intensive Therapy, Danderyds Hospital, Karolinska Institutet, Stockholm, Sweden
[3] Department of Anaesthesiology and Intensive Therapy, Wroclaw Medical University, Wroclaw, Poland
[4] Chair of Emergency Medicine, Wroclaw Medical University, Wroclaw, Poland
[5] Chair of Emergency Medicine, Collegium Medicum in Bydgoszcz, Bydgoszcz, Poland

Source of support: Departmental sources

Summary

Background: Organophosphorus compounds (OP) are a group of substances used in agriculture as pesticides and are also used as military poisoning agents (MPA). Intoxication by these agents may cause severe systemic disturbances related to both the exposure time and lethal agent concentration. Toxic effects result from an excess of the endogenous neurotransmitter, acetylcholine (ACh), because decomposition of Ach by cholinesterases is blocked by OP.

Case Report: The authors describe a case in which an acute OP poisoning was managed both conventionally and with cholinesterase substitution by blood transfusion.

Conclusions: Whole blood transfusion could be beneficial in the treatment of these life-threatening medical conditions.

key words: **organophosphate poisoning • acetylcholinesterase substitution • whole blood transfusion**

Full-text PDF: http://www.medscimonit.com/fulltxt.php?ICID=881922

Word count: 1086
Tables: –
Figures: –
References: 15

Author's address: Piotr Harbut, Department of Anaesthesiology and Intensive Therapy, Danderyds Hospital, 18288 Stockholm, Sweden, e-mail: piotr.harbut@ds.se

Background

Organophosphorus compounds (OPs) are chemical substances that pose a significant toxicological threat. OPs poisoning prevail in developing countries in industry and agriculture, both in acute and chronic forms [1]. Their availability and toxicity involve them in accidental intoxications and suicides.

The OP penetrates via the respiratory tract, alimentary tract and dermal integuments. With the increase of endogenous acetylcholine concentration, these substances affect muscarinic ACh receptors functions (central nervous system, heart muscle, bronchi, alimentary tract) and nicotinic ACh receptors (muscular lamina), and they exert direct toxic influence on the central nervous system [2,3]. OP affects cholinesterase of all types, including acetylcholinesterase (AChE), which is found mainly in the tissues transmitting nerve impulses, in erythrocytes cellular membrane and in pseudocholinesterase (butyrylcholinesterase, BChE) which is present in plasma, liver, pancreas and adrenal glands. Over the course of time, OP-cholinesterases complex becomes irreversible [4]; the complex dissociation being a process that is 10^{12} times slower than its formation [5].

AChE reconstruction takes place and it is assessed as 1% a day, whereas BChE reconstruction seems to be a faster process [6].

Toxic effects of OP include a wide range of symptoms, and death resulting from poisoning may take place within several seconds or minutes [7] due to heart beat disturbance, pulmonary insufficiency or multi-organ failure. Standard treatment of OPs poisoning includes atropine administration, AChE restoration therapy with oximes, and general intensive care for the prevention of secondary organ damage.

Case Report

A 16-year-old male rural resident was admitted to the Acute Poisonings Ward of the Specialistic Hospital in Wrocław, Poland due to suicidal oral poisoning with Parathion, an OP pesticide. The poisoning occurred 4–5 h before the patient was seen in the hospital. Delayed diagnosis hindered application of oximes before the admission to the Acute Poisonings Ward, and the patient had received only atropine. On admission, his Glasgow Coma Scale was 11, he revealed contracted and non-sensitive to light pupils, unobstructed respiratory tract and respiration rate 32/min.

Oxygen by mask was applied with 50% concentration. On auscultation, prolonged vesicular murmur was detected and single dry rales were heard. His systemic blood pressure was 100/55 and ECG noted normogram and accelerated sinus rhythm 125/min. The skin was pale and moist, and his body temperature was 37.4°C.

The patient's abdomen was extended and tender. Vomiting and diarrhea appeared, as well as sialosis and urine incontinence. Blood gas analysis revealed respiratory acidosis (pH 7.26) with carbon dioxide retention (paCO2 6.8kPa) and tendency towards hypoxia (paO2 7.6kPa at FiO_2 0.5).Toxicological screening for alcohols, salicylates and paracetamol was negative.

On the first assessment, cholinesterase activity determined by colorimetry was 12% [8] and after 6 hours it dropped below the determination level. Routine treatment with atropine infusion (totally up to 100 mg/day) and obidoxime 3 mg/kg every 8 hours was introduced. Due to psychomotor hyperactivity and anticonvulsive prophylaxis, benzodiazepine group drugs were intravenously administered. Multiorgan failure symptoms increased despite administered treatment, including pulmonary, hepatic and renal insufficiency, alimentary tract disturbances and CNS. Hence, the patient received sedation and intratracheal intubations were applied. Respirator treatment with pressure-controlled ventilation (PCV) was initiated with the respiration rate 14/min, PEEP 5 cm H_2O, PIP 18 cm H_2O, and FiO_2 0.4. Although the treatment was continued, the patient's condition worsened, symptoms of paralytic obstruction of gastrointestinal tract were observed and pulmonary dysfunction was noted. On the fifth day of treatment (the third day of ventilation) cholinesterase concentration still remained undetectable; hypotonia and bradyarrhythmia increased. In the experience of the medical staff, in patients intoxicated with OP, such symptoms usually preceded circulatory arrest.

Although there were no hematologic indications (hemoglobin level 11.4 g/dl), the trial of cholinesterase substitution was made by 500 ml of full blood transfusion. Six hours after the transfusion, the patient's condition improved, and respirator treatment was discontinued. At that moment, AChE level was 55%. The enzyme serum level on the next day dropped to 44%. The treatment with anticholinergic agents and obidoxime was continued, and the levels of pseudocholinesterase and cholinesterase increased gradually. At the same time, the patient's consciousness improved so that it was possible to discharge him home on the 16th day after his admission to the hospital.

Discussion

A total of 19 patients were treated in our centre for similar intoxications over the past 4 years. During the 2 years preceding cholinesterase substitution, 11 patients were treated and 7 of them required respirator treatment, and 6 patients died despite routine obidoxime and atropine administration (high doses in some cases).

During the next 2 years, cholinesterase activity early substitution by full blood transfusion was introduced in 7 patients with OP intoxication; the enzyme initial levels were 18–23%. After the transfusion, cholinesterase level increased up to 48–55%. Respiratory insufficiency requiring respirator treatment was not observed in any of these patients and they could leave the hospital without any serious sequels. The 7th patient was admitted in agonal condition with bradyarrhythmia 16/min, and although treatment was initiated, he died before blood transfusion could be performed.

OP intoxications are potentially fatal poisonings which result from both accidental and purposeful contact with the toxic substance. These poisoning are acute or chronic, with the risk of remote consequences, and have been discussed by Spielberg and Hellman [9]. The goal of this case report is to present additional therapeutic options in the acute stage of intoxication in patients with extremely low cholinesterase, in whom atropine or specific antidote treatment

were ineffective due to the formation of irreversible combination of OP and cholinesterase.

Doenicke et al discussed the possibility of plasma use after suxamethonium application [10] in patients with prolonged muscular block caused by BChE congenital insufficiency, and suggested full blood transfusion as a possible alternative for exogenous enzymes substitution. Another possible benefit of whole blood transfusion could be delivering a certain amount of erythrocyte cholinesterase – a potential target substrate for OP. Increasing the AChE activity over 30% correlates with normal neuromuscular transmission and possibly better weaning conditions, which could influence the overall outcome [11]. The application of blood specimens in order to substitute cholinesterases in OP poisoning, can lead to restoration of enzymatic function by its bioscavenging effect [12]. According to Güvens, similar effects have been reached by plasma exchange therapy by plasmapheresis [13]. Other promising strategies include specific administration of human BChE substitutes [14,15]. Bioscavenging therapy could influence the effectiveness of conventional reactivator/atropine-based management.

Conclusions

From our experience, early blood transfusion can reduce the extent of toxic symptoms and prevent further progression of toxic effects of OP. This concept, however, needs further evaluation under the RCT conditions.

References:

1. Cataño HC, Carranza E, Huamaní C, Hernández AF: Plasma cholinesterase levels and health symptoms in peruvian farm workers exposed to organophosphate pesticides. Arch Environ Contam Toxicol, 2008, 55: 153–59
2. Lee EC: Clinical manifestations of sarin nerve gas exposure. JAMA, 2003, 290(5): 659–62
3. Rickett DL, Glenn JF, Beers ET: Central respiratory effects versus neuromuscular actions of nerve agents. Neurotoxicology, 1986; 7: 225–36
4. Broomfield CA, Kirby SD: Progress on the road to new nerve agent treatments. J Appl Toxicol, 2001, 21(Suppl.1): S43–46
5. Eddleston, M, Szinicz, L, Eyer P, Buckley N: Oximes in acute organophosphorus pesticide poisoning: a systematic review of clinical trials. Q J Med, 2002; 95(5): 275–83
6. Tokuda Y, Kikuchi M, Takahashi O, Stein GH: Prehospital management of sarin nerve gas terrorism in urban settings: 10 years of progress after the Tokyo subway sarin attack. Resuscitation, 2006, 68: 193–202
7. Medical Management of Chemical Casualties Handbook (3rd ed.), USAMRICO, Aberdeen Proving Ground, MD (2000)
8. Caraway WT: Photometric determination of serum cholinesterase activity. Am J Clin Pathol, 1956, 26: 945
9. Spiegelberg U: Psychopatologisch-neurologische Spät- und Dauerschäden nach gewerblicher Intoxikation durch Phosphorsäureester (Alkylphosphate). Proc. Int. Congr. Occup. Tealth 14th, 1963. Excerpta Med. Found. Int. Congr. Ser. N 62, 1178–80
10. Doenicke A, Schmidinger ST, Krumey I: Suxamethonium and serum cholinesterase. Comparative studies *in vitro* and *in vivo* on the catabolism of suxamethonium. Bri J Anaesth, 1968; 40: 834
11. Thiermann H, Szinicz L, Eyer P et al: Correlation between red blood cell acetylcholinesterase activity and neuromuscular transmission in organophosphate poisoning. Chem Biol Ineract, 2005, 157–58: 345–47
12. Peter JV, Moran JL, Pichamuthu K, Chacko B: Adjuncts and alternatives to oxime therapy in organophosphate poisoning – is there evidence of benefit in human poisoning? – A review. Anaesth Intensive Care, 2008; 36: 339–50
13. Güven M, Sungur M, Eser B: The effect of plasmapheresis on plasma cholinesterase levels in a patient with organophosphate poisoning. Hum Exp Toxicol, 2004; 23(7): 365–68
14. Aurbek N, Thiermann H, Eyer F et al: Suitability of human butyrylcholinesterase as therapeutic marker and pseudo catalytic scavenger in organophosphate poisoning: a kinetic analysis. Toxicology, 2009; 259(3): 133–39
15. Cerasoli DM, Griffiths EM, Doctor BP et al: *In vitro* and *in vivo* characterization of recombinant human butyrylcholinesterase (Protexia) as a potential nerve agent bioscavenger. Chem Biol Interact, 2005; 157–58: 363–65