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The Appropriate Use of Activated Charcoal in Pharmaceutical and Toxicological Approaches

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Abstract

Activated charcoal has the ability to adsorb toxic materials, substances, poisons introduced to digestive system including stomach and intestine. The objectives of this study were to review the literature for updates in using activated charcoal for therapeutic purposes. The recent evidence of literature supports the idea of using single use of activated charcoal (SDAC) following overdose of a toxin, chemical substance, drug, or poison. The best results are obtained if activated charcoal is administered immediately following the intake of the chemical substance, however after 6 hours, SDAC still works efficiently. Low doses of activated charcoal can be given, particularly if side effects are likely to be encountered.

Keywords: Activated Charcoal; Single Dose of Activated Charcoal (SDAC); Poison; Toxin; Poison

Introduction

Activated carbon is made of a carbonaceous material that has a great surface area and porous structure as a consequence of exposing the raw materials to high temperature. The physical properties of activated carbon permit its adsorption of materials from liquids and gases [1]. The surface area of one gram activated charcoal may reach 800-1200m2, and superactivation of charcoal gives it more surface area that has been estimated to reach 2,800-3,500 m2/g which involves the ability to adsorb greater quantities of drugs [2-4]. Hoegberg et al. [5] conducted a study to identify the maximum adsorption capacities of amitriptyline and paracetamol, separately and in combination, to activated charcoal. The methods used involved the choice of activated charcoals (Carbomix® and Norit Ready-To-Use) that were examined in vitro. The solutions were adjusted at pH 1.2 and pH 7.2, preparations of 0.250 g activated charcoal with paracetamol and/or amitriptyline were mixed and incubated.

Several ratios of activated charcoal to drug were made in the following pattern: 10:1, 5:1, 3:1, 2:1, and 1:1. Vials containing mixed-drug adsorption had the same activated charcoal: paracetamol ratios, in which amitriptyline dose (0.08 g) was added as fixed dose to all samples. To determine the concentrations of drug in the liquid phase, high-performance liquid chromatography (HPLC)/UV-detection was used. Study findings showed that the maximum adsorption capacities of amitriptyline were 0.49 g/g Carbomix® and 0.70 g/g Norit Ready-To-Use, and that of paracetamol were 0.63 g/g Carbomix® and 0.72 g/g Norit Ready-To-Use. No significant differences in the adsorption were attributed to the pH differences. Neuvonen et al. [6] conducted a study to study the inhibitory effect of activated charcoal 50 g suspended in water on the absorption of digoxin, phenytoin and aspirin in 6 healthy volunteers. Results showed that both of digoxin and phenytoin were not almost absorbed when activated charcoal was immediately ingested following the drug administration. On the other hand, the absorption of aspirin was inhibited by 70%. As a conclusion, due to the consideration that larger doses of drugs exhibit low absorption, giving an appropriate amount of activated charcoal has beneficial effects of in the treatment of acute intoxication, although it may be delayed for hours.

Nabais et al. [7] conducted a study to investigate the adsorption behavior of tricyclic antidepressant, amitriptyline hydrochloride using various activated charcoals. A virtual simulated gastric and intestinal fluid at 37°C was made to study the adsorption behavior. The used activated charcoals included (carbomix), commercial and ready- made, in addition to two activated charcoals prepared

in their laboratory. The results showed that carbomix had the highest adsorption capacity (120 mg/g) for gastric and intestinal fluids. Jurgens et al. [8] conducted a study to evaluate the influence of activated charcoal given within the first 6 h following drug intake in addition to exploring the influence of drug characteristics upon exposure to drug. A meta-analysis involving 64 studies was conducted. Study findings showed that activated charcoal given within 5 minutes following administration of a drug was able to significantly lower the adsorption of drug up to 88.4%. It was also interesting to find the continuous significant effect of giving activated charcoal after drug intake by 4 hours. The results also showed that activated charcoal is mostly effective in large doses.

Mohamed et al. [9] conducted a study to investigate compliance of patients using a randomized controlled trial (RCT) in Sri Lanka. The study included 1103 patients who were randomized to single or multiple doses of super-activated charcoal. Study findings showed that 559 patients received one dose and 544 receive six doses. It was also shown that 88 patients failed to complete their course. It was also shown that about 3% of patients did not accept the first dose, and about 12% did not accept the sixth dose. It was interestingly to find fewer efforts were input to convince patients to ingest the first dose compared with that for sixth dose. Chyka et al. [10] conducted a study to investigate the effect of using activated charcoal as a single dose which implies giving orally an aqueous preparation of activated charcoal following the ingestion of a toxic material. The efficacy of using activated charcoal decreases over time as evidenced by volunteer studies. The use of activated charcoal should be used in case of ingestion of a potentially toxic material which is known to be adsorbed to activated charcoal.

Eddleston et al. [11] conducted a study in view of the light that there are increased cases of self-poisoning in rural Asia, estimated as 10–30 times higher than in the West. The use of activated charcoal is of choice as an early intervention to bind toxic materials and prevents their absorption. Activated charcoal can be given as a single dose of charcoal after the ingestion of toxic material through one hour. On the other hand, multiple doses of activated charcoal have the potential of decreasing the risk of toxic materials through interfering with enterohepatic or enterovascular circulations. Wang et al. [12] conducted a study to investigate the influence of activated charcoal on apixaban exposure in human subjects. Apixaban has been used therapeutically for its properties as a potent inhibitor of both free and prothrombinase-bound factor Xa [13,14]. Other therapeutic uses of apixaban included the prevention of stroke and systemic embolism and for thromboprophylaxis after the surgery of elective knee or hip replacement surgery [15,16]. In their study, Wang et al. [12] gave a single-dose apixaban (20 mg) either alone or with activated charcoal at 2 or 6 h post-dose to healthy subjects. The study findings showed that the administration of activated charcoal following the exposure to apixaban lowered its concentration and improved its elimination.

Conclusion

Among patients who had acute overdose of poisons, chemical substances, and/or toxins, single dose of activated charcoal (SDAC) is considered as a significant therapeutic choice. Studies on literature have confirmed that SDAC has the ability to significantly lower systemic drug absorption following its short intake.

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