Medsaway® System Deactivation of Drugs in Abuse Deterrent Formulations; An Investigation using Oxycontin as a Model Compound

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Abstract

In many households and healthcare facilities, medications accumulate over time. Improper storage or disposal of these drugs poses human safety and environmental contamination risks. Federal guidelines provide suggested methods of disposal including use of take-back programs and mixing with undesirable substances prior to throwing into the trash. These methods do not adequately address safety, environmental and convenience issues. A new product, Medsaway®, provides a simple and convenient way of complying with federal guidelines, while reducing both the effect on the environment and safety risks associated with normal trash disposal of medications. Medsaway® contains activated carbon and renders drugs inactive by adsorption in the presence of water.

Opioid analgesics are sometimes subject to abuse by parenteral administration of drugs intended for oral dosing. To discourage this improper use, some newer narcotics incorporate abuse deterrent means to make extraction of the active pharmaceutical into an injectable form difficult. One such means is to include a viscosifier, such as polyethylene oxide (PEO), which deters tampering by dissolution. A successful example of a newer drug formulation using PEO as an abuse deterrent component is Oxycontin, a product of Purdue Pharma.

This study examines the ability of Medsaway® carbon to deactivate a drug in a commercially available abuse deterrent formulation, using Oxycontin (10 mg tablet) as a model formulation. Another aim of the study is to independently examine the ability of carbon to deactivate two additional model compounds (dexamethasone phosphate and lidocaine hydrochloride), comparing efficiency in the presence and absence of PEO.

Our results indicate that Medsaway® was shown to deactivate 99% of Oxycontin (10 mg tablets) in 4 days, with the majority of that deactivation occurring within one day. It was also shown to deactivate 97% and 98% of lidocaine hydrochloride and dexamethasone phosphate, respectively, in the presence of 2% PEO (5,000,000 MW). The presence of PEO was not found to significantly affect deactivation under the conditions evaluated.

Introduction

Many households and healthcare facilities accumulate an assortment of unused medications over time. This may be a consequence of changes in prescription, discontinuing use of a medication once symptoms improve, or shelf life expiration. Improper storage or disposal of these unused and expired medications poses a combination of safety risk to individuals, and contamination risk to our environment. Unused pharmaceuticals are a safety danger when retained, and an environmental hazard when disposed.

From a safety perspective, unauthorized access to unused pharmaceuticals represents a significant and potentially deadly hazard. An estimated 71,000 patients are seen in emergency departments each year because of medication poisonings (excluding recreational drug use).

Over 80% of these visits were because an unsupervised child found and consumed medications[1].

From an environmental hazard perspective, pharmaceuticals are now well documented as environmental contaminants. As of 2009, there were over 1000 published reports of the occurrence of pharmaceuticals in sewage, surface waters, ground waters, and elsewhere[2]. In one landmark study, in a sample of 139 streams from 30 different states, 80% contained contaminants including pharmaceuticals[3].

To address these issues, the FDA has worked with the United States Office of National Drug Policy to issue guidelines titled: "How to Dispose of Unused Medications." Separately, a partnership between the U.S. Fish and Wildlife Service, the American Pharmacists Association, and the Pharmaceutical Research and Manufacturers of America has established the SmartRx campaign to educate consumers on proper disposal of their medications. Both guidance's urge consumers not to flush medications down the toilet or drain. If there are no specific disposal instructions for a medication, consumers are directed to participate in take-back programs or to dispose of medications in the trash by co-mixing with an undesirable substance (such as kitty litter, coffee grounds, or sawdust) to make it less appealing for children and pets to eat. In certain cases, strong narcotics are advised to be flushed in order to minimize the chances of diversion or accidental exposure to children.

While the methods suggested in these guidance documents provide some protection, they do not satisfactorily address safety, environmental and convenience issues. Discarded drugs can still be reclaimed from trash for diversionary purposes and present acute poisonings hazards for wildlife scavengers. Mixing with the currently recommended undesirable substances has not been shown to decrease availability of drugs to groundwater when placed in landfills. The recommended procedure is messy, utilizes materials that may not be available to consumers, and lacks procedure clarity (for example, how much cat litter is required?).

Alternative pharmaceutical take-back programs utilize incineration, which can produce toxic air emissions[4]. Further, take-back and other collection events are not always available, or may require long distance travel, and will encourage consumers to stockpile unwanted medications until it is convenient to make a trip to turn them in. Consumers have expressed concerns regarding take-back programs including convenience, insufficient time, privacy concerns and preferences for alternative routes of disposal (such as flushing). In countries with long-established take-back programs (such as the UK), only a minority of the public makes use of the service[2].

The Medsaway® System provides a simple and convenient way of complying with the guidance's listed above, while reducing both the effect on the environment and safety risks associated with normal trash disposal of medications. The system is comprised of a conveniently pre-packaged sealable outer pouch containing a proprietary Medsorb carbon, self-contained in an inner water permeable pouch. Unused tablets, capsules, liquids, or used patches are placed in the outer pouch, water is added, and the pouch is sealed and thrown into normal household trash. In use, the drugs will dissolve into the water and react with the Medsorb carbon in a manner to render it insoluble and therefore inactive. This drug deactivation process starts immediately, and will generally occur over several hours. The full deactivation time will vary, and is dependent on how quickly the drug dissolves into the added water.

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abuse deterrent means to make extraction of the active pharmaceutical into an injectable form difficult. One such means is to include a viscosifier, such as polyethylene oxide (PEO), which deters tampering by dissolution[5]. A successful example of a newer drug formulation incorporating PEO as an abuse deterrent component is Oxycontin, a product of Purdue Pharma[6].

This study examines the ability of Medsaway® carbon to deactivate a drug in a commercially available abuse deterrent formulation, using Oxycontin (10 mg tablet) as a model compound. The recommended tablet to carbon ratio for Medsaway SP was used in our evaluations. Another aim of the study is to independently examine the ability of carbon to deactivate two additional model compounds (dexamethasone phosphate and lidocaine hydrochloride), comparing efficiency in the presence and absence of PEO.

Materials

Oxycontin (10 mg tablets, Purdue Pharma LP, Stanford, CT), dexamethasone sodium phosphate (Sanofi, Princeton, NJ), lidocaine hydrochloride (Sigma-Aldrich, St. Louis, MO), Medsorb carbon (Verde Environmental Technologies proprietary), distilled water.

Methods

Study 1

Single Oxycontin tablets were added to 1.5 grams of activated carbon and 5 ml distilled water. Samples were not disturbed until day of measurement. On days 1, 2, 4 and 7 the resulting gelled mixture was repeatedly rinsed, and the rinse solutions were separated from carbon to isolate any drug remaining in free (abusable) form. The rinses were then analyzed for total free drug content by UV-Vis spectrophotometry at an optimal wavelength.

A standard was prepared in the same manner with the exception that activated carbon was not present. The deactivation efficiency (in %) for each condition evaluated was measured by direct comparison to the untreated standard. Adsorbent blanks were prepared in the same manner with the exception that drugs were not present.

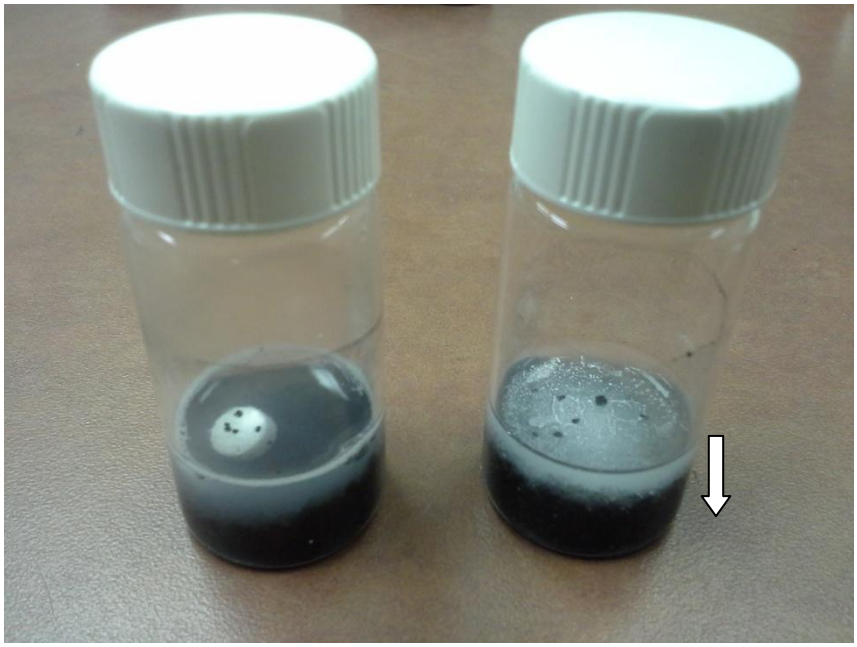
Study 2

Dexamethasone phosphate and lidocaine hydrochloride (150 mg) were separately added to 1.5 grams of activated carbon and 5 ml distilled water or 5 ml 2% PEO. Samples were left undisturbed for 4 days. Samples were repeatedly rinsed to dissolve the gel and separate any drug remaining in free form. The rinses were collected and presence of drug in solution was measured by UV-Vis spectrophotometry at an optimal wavelength.

A standard was prepared in the same manner with the exception that activated carbon was not present. Adsorbent blanks were prepared in the same manner with the exception that drugs were not present.

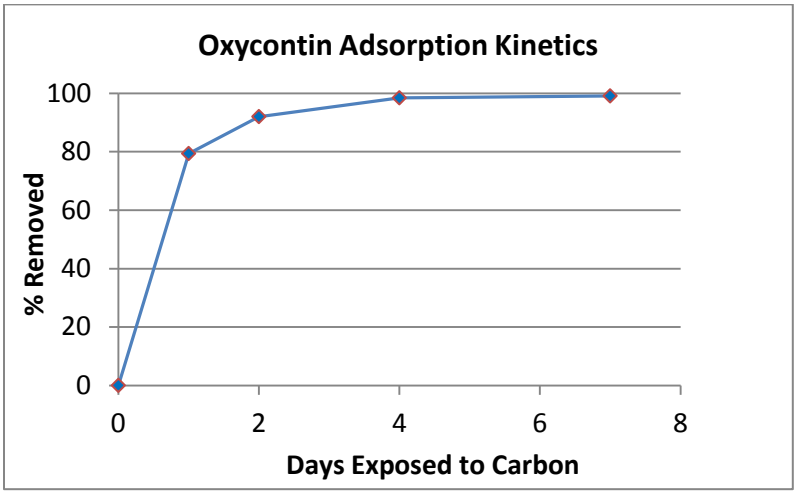
Results

The oxycontin tablets were found to absorb water over time, creating a hydrogel mass as pictured below (an initial time-point on left, a 24 hours time-point on right. Drug deactivation would occur through diffusion of the dissolved drug into the carbon layer (depicted by the arrow on right).



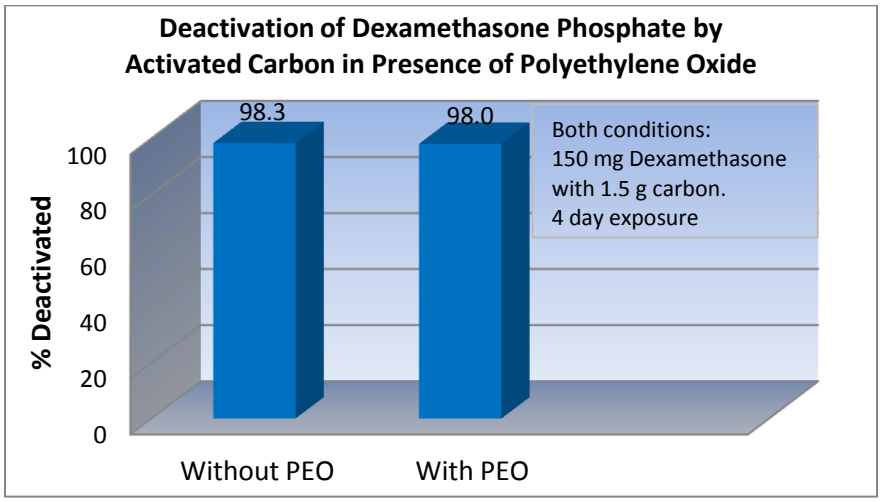
Our results indicate that the oxycodone HCl freely diffuses from the gel mass into the carbon layer, where it becomes insolublized and deactivated via an adsorption process. Approximately 80% of the drug was deactivated after 24 hours, and 99% was deactivated by 4 days. The rate of deactivation found over the 7 day test period is depicted in the figure below.

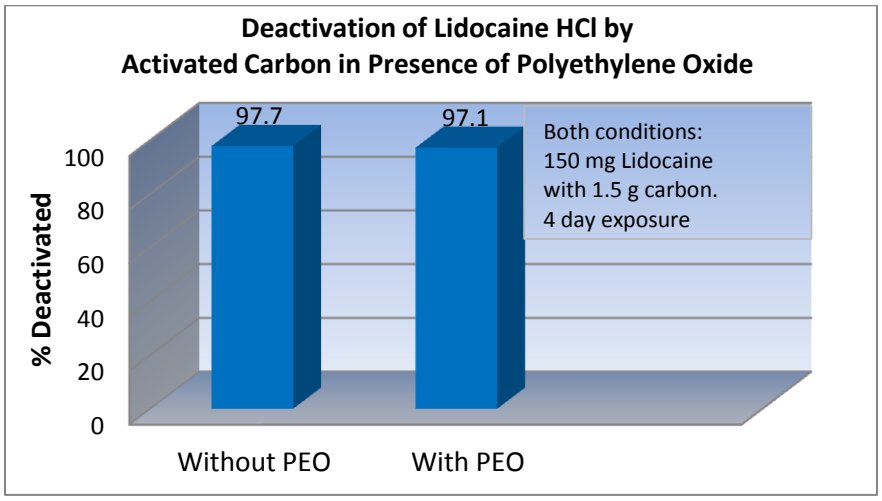
Study 1. The following chart illustrates amount of Oxycontin deactivated over time:



In the second part of the study, we investigated the deactivation of model compounds Dexamethasone and Lidocaine in the presence and absence of PEO. In both cases, there was a slight, but generally insignificant effect from PEO. Both compounds showed rates of deactivation of approximately 97-98% at the conditions tested, as illustrated in the figures below.

Study 2. The following charts illustrates amount of dexamethasone phosphate and lidocaine hydrochloride deactivated after 4 days:





Discussion

These studies were designed to examine the deactivation efficiency of Medsaway® products, using scaled versions of recommended tablet to carbon ratios. MedsAway® was shown to be efficacious in deactivating model compounds in the presence of the viscosifying agent polyethylene oxide. Our results indicate there is little difference in deactivation efficiency of drug when PEO is or is not present.

Conclusion

Medsaway® has been shown to deactivate model compounds in the presence of abuse deterrence viscosifying agents.

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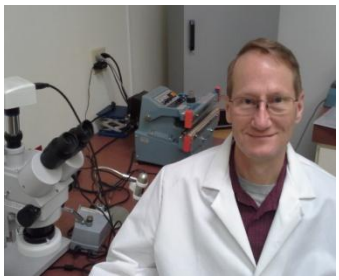
About the Author:



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Bill has B.A. degrees in Chemistry and Biology from Augsburg College, and an M.S. degree in Genetics from the University of Minnesota. He has over 26 years of experience in the Medical Device and Pharmaceutical industries. Prior to Verde, he served as a Sr. Device Scientist at Travanti Pharma, where he managed R&D and preclinical activities for a self-contained iontophoretic device used in the treatment of pain associated with Lateral Epicondylitis. Prior to Travanti, he worked as a Sr. Product Development Engineer at St. Jude Medical in the development of heart guide catheter systems. Bill is listed as an inventor on 13 US and International patents.