

# Effectiveness of Devices Purported to Reduce Flatus Odor

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**OBJECTIVE:** A variety of charcoal-containing devices are purported to minimize problems with odoriferous rectal gas; however, the evidence supporting the efficacy of these products is virtually all anecdotal. We objectively evaluated the ability of these devices to adsorb two malodorous, sulfide gases (hydrogen sulfide and methylmercaptan) instilled at the anus.

**METHODS:** Via a tube, 100 ml of nitrogen containing 40 ppm of sulfide gases and 0.5% H<sub>2</sub> was instilled at the anus of six healthy volunteers who wore gas impermeable Mylar® pantaloons over their garments. Since H<sub>2</sub> is not adsorbed by charcoal, the fraction of the sulfide gases removed could be determined from the concentration ratio of sulfide gas: H<sub>2</sub> in the pantaloon space relative to the ratio in instilled gas.

**RESULTS:** Measurements with no device in place showed that subjects' garments removed 22.0 ± 5.3% of the sulfide gases, and results obtained with each device were corrected for this removal. The only product that adsorbed virtually all of the sulfide gases was briefs constructed from an activated carbon fiber fabric. Pads worn inside the underwear removed 55–77% of the sulfide gases. Most cushions were relatively ineffective, adsorbing about 20% of the gases.

**CONCLUSIONS:** The ability of charcoal-containing devices to adsorb odoriferous rectal gases is limited by incomplete exposure of the activated carbon to the gases. Briefs made from carbon fiber are highly effective; pads are less effective, removing 55–77% of the odor; cushions are relatively ineffective.

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## INTRODUCTION

While the passage of odoriferous rectal gas is a universal phenomenon, some individuals believe that the malodor of their gas exceeds acceptable levels. The fraction of the population with this problem is unknown since the physician is consulted only by subjects who think their gas is a severe social liability. Presumably, a much larger fraction of the population, many of whom have an episodic problem, never reach the attention of physicians. The perception that malodorous rectal gas represents an appreciable problem has led to the commercial development of a variety of external devices that utilize the adsorbent properties of activated carbon. Unfortunately, the efficacy of these devices consists almost entirely of personal testimonials. In the present study, we report the results of objective testing of 11 products purported to adsorb the odoriferous compounds passed in rectal gas.

## MATERIALS AND METHODS

### *In Vivo Studies*

Six healthy adult volunteers (three male and three female) participated in this study in which we measured the efficiency

with which various devices removed sulfide gases infused at the anus. The gas infusion tubing consisted of a 50 cm long polyethylene catheter (external diameter: 2.42 mm). Using heat, a 2 mm segment of the distal end of the catheter was made to project at a right angle and the tip was flared. The catheter was situated such that the flared end projected outward from the anus, with the remainder of the tubing passing between the cheeks of the buttocks (beneath the underwear) to the lower back area. The subjects then donned their usual garments as well as previously described pantaloons fabricated from Mylar (1), which were sealed at the thighs and the waist using elastic bandages. Although not perfectly gas-tight, the pantaloons, which contained roughly 20 L of air, prevented gross convection into the atmosphere. Gas was sampled via a catheter taped to the inner side of the anterior thigh of the pantaloons. The VA IRB committee approved this study, and written informed consent was obtained from all subjects.

Eleven different devices containing activated carbon were tested in each subject (see Table 1). These devices consisted of four types of pads worn inside the underwear, two types of briefs designed to be worn over the subject's conventional briefs, and five types of seat cushions. The pads were attached to the inside of the underwear opposite the anal area using double-sided tape. The briefs were chosen from three sizes

**Table 1.** Deodorizing Devices Tested

Number	Type of Device	Product Name	Activated Carbon Component	Area of Activated Carbon (cm <sup>2</sup> )
1	Pad	GasMedic <sup>®</sup> underair pad (model UAP8-P1)*	Uncovered activated carbon cloth	210
2	Pad	GasMedic <sup>®</sup> underair pad (model UAP8-C1)*	Fabric-covered charcoal	210
3	Pad	Flat-D <sup>®</sup> (model FD-R)†	Fabric-covered charcoal	179
4	Pad	Flat-D <sup>®</sup> (model FD-D)†	Fabric-covered charcoal	144
5	Brief	Underease protective underwear‡	Fabric-covered charcoal pad (attached to brief)	64
6	Brief	GasMedic <sup>®</sup> underair brief*	Brief made of covered activated carbon cloth	variable
7	Cushion	Flat-D <sup>®</sup> (model CP-B)*	Fabric-covered activated carbon cloth	1764
8	Cushion	GasMedic <sup>®</sup> classic*	Charcoal under fabric and sponge	961
9	Cushion	GasMedic <sup>®</sup> ultra*	Charcoal under fabric and sponge	961
10	Cushion	GasBGon <sup>®</sup> *	Charcoal under fabric and sponge	900
11	Cushion	Flatulence filter <sup>®</sup> ‡	Charcoal under fabric (over sponge)	1600

\*Dairiair, LLC., Greenville NC, 27858.

†FLAT-D Innovations, Inc., Cedar Rapids IA, 52410.

‡Under-Tec Corp., Pueblo CO, 81001.

‡UltraTech Products, Inc., Houston TX, 77083.

to fit the subjects. The cushions were situated between the subjects' regular garments and the pantaloons. The internal devices were tested with the subjects standing and sitting whereas the cushions were tested only in the sitting position. The subjects were instructed not to pass endogenous gas during the study period.

The infused gas consisted of 100 ml of nitrogen containing about 40 parts per million (ppm) of two malodorous intestinal gases, hydrogen sulfide (H<sub>2</sub>S) and methylmercaptan (CH<sub>3</sub>SH), and 5,000 ppm of hydrogen (H<sub>2</sub>). The gas was instilled at the anus over a 2-s period. Immediately following gas instillation (while the subject remained sitting or standing), air inside the pantaloons was constantly mixed via vigorous palpation over a 30-s period. Twenty milliliters samples of gas were obtained from the pantaloons at 5 s and 30 s. Hydrogen, which does not react with carbon (see results), served as an indicator of the concentration of an infused gas that is not removed by the devices. Studies were carried out with and without the device in place. The fraction of the infused sulfide gases removed by garments or the garments and the device during passage of gas from the anus to the pantaloon space was calculated from:

$$1 - ([\text{Sulfide gas}]/[\text{H}_2])_{\text{in pantaloons}}/([\text{Sulfide gas}]/[\text{H}_2])_{\text{infused}}$$

The efficiency of each device was expressed as the fraction of the sulfide gas escaping the garments that was removed by the device.

### *In Vitro Studies*

The ability of each product to adsorb the sulfide gases and H<sub>2</sub> was studied *in vitro*. Two grams of the activated carbon containing fraction of each device was placed in a 50 ml polypropylene syringe fitted with a stopcock, and the plunger was compressed to remove air from the syringe. Fifty milliliters of a mixture of the two sulfide gases (concentrations: 44 ppm) and H<sub>2</sub> (concentration: 56 ppm) was then aspirated into the syringe. After 30 s, gas was ejected into a

second syringe and analyzed for the concentrations of sulfide gases and H<sub>2</sub>.

### *Analyses and Calculations*

The gas chromatographic techniques used to analyze the gas samples have been described in detail previously (2). A sulfur chemiluminescence detector (Sievers Instruments, Inc., Boulder, CO) and a reduction gas detector (Trace Analytical, Menlo Park, CA) were used to determine the concentrations of the sulfide gases and H<sub>2</sub>, respectively. Quantitation was obtained via comparison of peak areas of the unknown with the areas of dilutions of authentic standards. Duplicate measurements were made at each time point for each posture for each device, and the mean of these two measurements was employed for calculations. All data are expressed as mean ± standard error (SE) of the mean. The significances of differences between various treatment groups were compared using paired *t*-test. Probability values of *p* < 0.05 were taken as significant.

## RESULTS

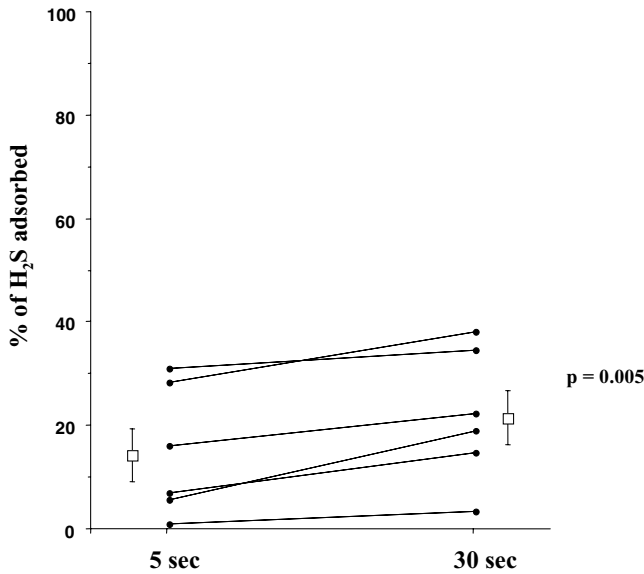
### *In Vitro Studies*

The mean concentrations of both H<sub>2</sub>S and CH<sub>3</sub>SH declined from concentrations of 40 ppm to <0.4 ppm after 30 s of incubation with the activated carbon containing portion of each the devices. The concentration of H<sub>2</sub> remained constant (pre- and postincubation concentrations of 56 ppm and 57 ± 1.6 ppm, respectively).

### *In Vivo Studies*

Measurements of H<sub>2</sub> concentration in the pantaloons at 5 s and 30 s after instillation at the anus showed a significant increase with time (15.8 ± 1.3 ppm at 5 s; 24.8 ± 1.3 ppm at 30 s (*p* = 0.005)).

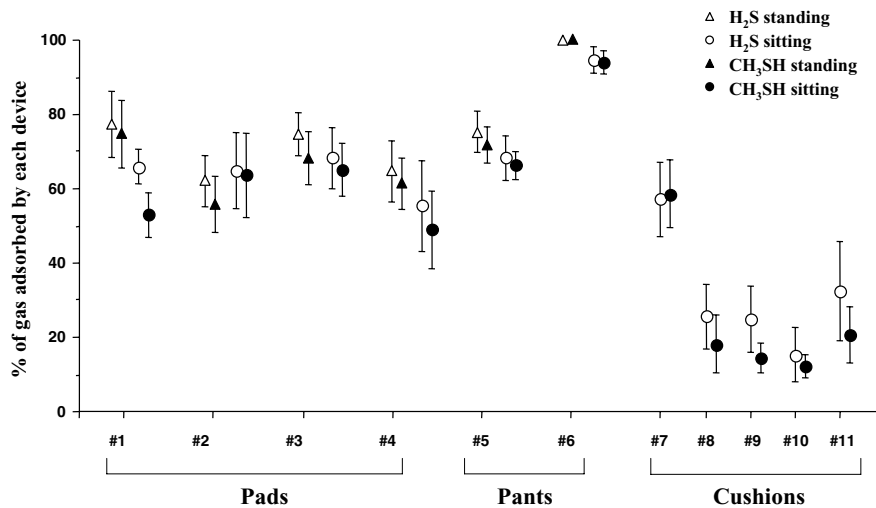
The percentages of H<sub>2</sub>S reacting with the garments of each of the six subjects are shown in Figure 1. These percentages averaged 14.8 ± 5.1% when measured at 5 s and 22.0 ± 5.3%



**Figure 1.** Fraction of instilled H<sub>2</sub>S removed by garments of each of the six subjects, determined 5 s and 30 s after instillation of gas at the anus.

at 30 s ( $p = 0.008$ ). Comparable data for CH<sub>3</sub>SH were  $18.3 \pm 5.3\%$  and  $24.8 \pm 5.2\%$  ( $p = 0.014$ ).

While the mean values for removal of the sulfide gases by the various devices were roughly similar for measurements obtained at 5 s and 30 s, the 5-s data showed much greater variability. Figure 2 shows the percentages of H<sub>2</sub>S and CH<sub>3</sub>SH removed by each of the products assessed at 30 s. While the devices tended to adsorb H<sub>2</sub>S with a slightly greater efficiency than CH<sub>3</sub>SH, the differences did not reach statistical significance for any product. No significant difference in efficacy was observed for any device in the sitting *versus* the standing posture or for males *versus* females (data not shown).



**Figure 2.** Fraction of sulfide gases instilled at the anus which were adsorbed by the various devices. (See Table 1 for details of each device.) Product number 6, briefs made from carbonized cloth, removed each of the gases more efficiently ( $p = 0.007$ ) than did any other device.

The pads (nos. 1–4) adsorbed means of 55–77% of the sulfide gases, with no statistically significant differences observed among the four products. The most effective product was underwear made from an activated carbon fiber fabric (no. 6), which removed >99% and >95% of the sulfide gases when standing and sitting, respectively. These values were statistically greater ( $p = 0.007$ ) than was observed with any other product. The second type of underwear tested (no. 5) which had a charcoal-containing pad adjacent to the anus, had an efficacy comparable to the pads. Of the five cushions tested, the device consisting of carbonized cloth (no. 7) covered by a very thin fabric removed about 60% of the sulfide gases in comparison to only about 20% for the four cushions in which the activated carbon was covered by a thicker layer of fabric or fabric plus sponge ( $p = 0.034$  for at least one of the sulfide gases for cushion nos. 7 *versus* cushions nos. 8, 9, 10, and 11).

**DISCUSSION**

In a previous study, we found a statistically significant correlation between the concentrations of H<sub>2</sub>S and CH<sub>3</sub>SH and the odor of human flatus (as assessed by human judges) and an improvement in malodor with the removal of these gases (1). Thus, these two sulfide gases appear to be major contributors to the noxious odor of flatus, and an intervention that reduces the volume of these gases should be beneficial to subjects who have a problem with flatus malodor.

Both of the sulfide gases, as well as a wide variety of other odoriferous volatiles, are adsorbed by activated carbon, and multiple externally applied devices containing activated carbon are available for purchase. The goal of the present study was to objectively measure the ability of these products to remove H<sub>2</sub>S and CH<sub>3</sub>SH from gas released at the anus.

As demonstrated in our *in vitro* studies, the charcoal-containing fraction of each device efficiently adsorbed H<sub>2</sub>S and CH<sub>3</sub>SH when contact was insured via containment of the charcoal and the gases in the enclosed space of a syringe. Thus, the efficiency of these devices in the physiological situation will be critically dependent upon contact between the charcoal element and rectal gas. Since such contact is not readily simulated in *in vitro* experiments, the present studies were carried out in human volunteers.

*In vivo* quantitation of the efficiency of the various devices requires knowledge of the volume of sulfide gases escaping the device relative to the volume of the gases passed per anus. Since the volume and composition of rectal gas is highly variable, we elected to employ an anal infusion of a bolus of air containing known concentrations of the two sulfide gases and H<sub>2</sub>. The natural passage of gas (hence, physiological exposure of the device) was roughly simulated via use of a 100 ml bolus of gas (the observed mean volume of a flatus passage (1)) infused over a 2-s period. The concentrations of the infused sulfur gases (40 ppm) were comparable to that of human flatus (mean H<sub>2</sub>S concentration: 20 ppm (1)). To facilitate measurement of the sulfide gas escaping the device, gas impermeable pantaloons fashioned from Mylar<sup>®</sup> were worn over the subject's garments. Since H<sub>2</sub> is not adsorbed by activated charcoal, the fraction of the infused sulfide gas that would have escaped into the atmosphere of the room could be determined from the ratio of sulfide gas: H<sub>2</sub> in the gas collected from the pantaloons relative to the ratio in the infusate.

Accurate assessment of the efficacy of the various products was complicated by the observation that an average of 15% and 22% of the H<sub>2</sub>S reacted with the subjects' garments in measurements obtained at 5 s and 30 s after instillation of gas at the anus (Fig. 1). Thus, the true contribution of the charcoal-containing device to sulfide gas removal required correction for removal by the garments. Since the H<sub>2</sub> concentration measurements showed that an appreciable fraction of the instilled gas was trapped inside the garments at 5 s, we elected to assess the efficacy of the devices from measurements obtained at 30 s with the caveat that this measurement could slightly overestimate effectiveness due to "retrograde" movement of the sulfide gases from the pantaloon space back into the charcoal-containing device and reaction of these gases with garments.

The activated carbon-containing products that purportedly reduce flatus odor consist of various types of pads worn inside

the underwear, briefs worn over underwear, and cushions used outside the garments. As shown in Figure 2, only one of these products, underwear manufactured from an activated carbon fabric (no. 6), adsorbed virtually all H<sub>2</sub>S and CH<sub>3</sub>SH instilled at the anus. This efficiency indicates that nearly all rectal gas comes into contact with the activated carbon cloth from which these pants were constructed. Pads that are secured to the inner side of the underwear adjacent to the anus (nos. 1–4) or are part of the underwear (no. 5) were less effective, removing 50–75% of the sulfide gases. This incomplete removal reflects the tendency of a rapid infusion of a 100 ml bolus of rectal gas to "blow-by" rather than to penetrate the pads. Lastly, four types of cushions (nos. 8–11) in which the activated charcoal was situated beneath a fabric and/or sponge were relatively ineffective, removing only about 20% of the sulfide gases. A cushion in which a layer of carbonized cloth was covered by a thin layer of fabric was appreciably more effective, removing about 60% of the sulfide gases.

We conclude that there is a device, briefs made from activated carbonized cloth, that removes virtually all sulfide gas released at the rectum, and, in all likelihood, this device will efficiently adsorb all other odoriferous gases. While reusable and allegedly regeneratable with heat, the life of this fairly expensive product (approximately \$70) has not been clearly determined. Various forms of pads are a less expensive alternative (\$10–\$20) but remove an average of only 50–75% of the sulfide gases, a removal that will reduce but not eliminate odor. There seems to be little utility for cushions containing activated charcoal given that they are relatively expensive (\$22–\$50), unwieldy, useful only when sitting, and seemingly rather ineffective.

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