Author's response to reviews

Title: Characterization of exposures to cleaning products used for common cleaning tasks in hospitals - a pilot study

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Author's response to reviews: see over
Dear Dr. Ozonoff,

We have revised the manuscript considering the most recent concerns of the two reviewers. We thank the reviewers for the careful evaluation of the technical information and for providing important suggestions on revising the language. The following is our point by point response to the reviewers’ comments.

Reviewer: Elise Pechter

Major compulsory revisions

1. “Qualitative assessment of inhalation exposures” (page 6) implies that the method of cleaning is not a factor in determining inhalation. Only intensity (specifically limited to volatility and concentration), duration and frequency are included in formula. Yet the paragraph describes product application methods. Is the formula used or not. If not, delete it, or clarify the modification to include product application method.

   In general, airborne concentrations of volatile organic compounds (VOC) in the air are function of exposure intensity, duration, and frequency. The intensity of exposures is function of several factors, such as VOC content in the products, room ventilation status, amount of product used, the volume of the room where cleaning takes place etc. In this study we qualitatively found that “product application procedures” can also impact the VOC airborne exposures. A very detailed description of these factors as potential exposure determinants will be presented in our next publication. For this crude qualitative assessment we assessed exposures by considering two important exposure determinants: “Product formulations” (= ingredients volatility and concentration) and then “Task” (= way that tasks are performed, plus task frequency and duration).

   To address the confusion that this formula brings to the reader, as described by the reviewer, we have deleted the formula and revised the language.

2. VOC must be defined. EPA’s definition would exclude some ingredients, only including C6-C16.

   There are different definitions for what is a volatile organic compound (VOC). In general, VOCs are defined as substances that evaporate at the normal condition of temperature and pressure. The definition is based on the compounds’ boiling point (BP). Some countries define a VOC as an organic compound with a boiling point < or = 250ºC. Others use BP=200ºC as cut point. Wolkoff 1998 defines VOC as organic compounds with BP from 0-400ºC.
To address reviewer’s comments we have included the definition for VOC on the methods section: “qualitative assessment of inhalation exposures” on page 6.

3. The discussion is 7 pages long, and includes some results as well as conclusions and recommendations. Numbers 2 and 4 should precede number 3 logically: 1) products are mixtures, 2) cleaning results in exposures (inhalation and dermal) and 3) exposures cause harm. Parts of the discussion appear to be an evaluation of DREAM rather than a report on its applicability to this pilot study. The conclusions and recommendations embedded in this section could be eliminated.

- Logically we thought the study would flow if we focus first on “Products” and then on “Exposures”. The first part of the study describes the “Products” and their “Ingredients of Concern”. In the second part we assess the potential for exposures to ingredients of concern. The discussion flows the same way with the study design: a) products are mixtures, b) contain ingredients of concern, and c) there is a potential for exposure to these ingredients of concern.

- To address reviewer’s the second point, we have modified the language on the dermal exposure discussion. Changes have been made on the applicability of DREAM for cleaning and conclusions on the importance of dermal exposure assessment by future studies.

4. The discussion (page 20) about the limitations of green cleaners, for example is incomplete, and disconnected from the rest of the article. EPA will not allow “green” labels on any FIFRA approved disinfectants. Therefore this discussion is irrelevant for any product with disinfection properties.

We have deleted the paragraph with discussion on the green cleaners and reformulated the importance of considering “task” or “potential for exposure” in addition to the product formulation for prevention strategies.

Minor revisions:

1. Two new articles are cited in the background, but the references are not added until later in the paper. We have revised this paragraph.
2. “Most hazardous ingredients” used (p5) should be altered to ingredients most likely to cause respiratory and skin adverse affects. Corrected to: ingredients of concern
3. Add reference to the sentence ending: “… the reader can refer to the DREAM method.”
   
   Done

4. The language regarding hazard (page 5) confuses potential for exposure and potential for harm. Items 1, 3, and 4 refer to the possibility that the ingredient was present in the product, whether it was present in higher concentrations and whether it could become airborne. Only item 2 refers to the potential to cause health effects. This should be clarified.
   
   We have used the following strategy to specify the selection criteria for identification of ingredients of concern.
   
   Because cleaning products contain many ingredients, it was important to identify the ingredients that are markers of exposure for the purpose of further exposure evaluation. The ingredients were selected by considering both a) the human health effects with respect to respiratory and dermal sensitization and irritation, and b) the potential for its workplace exposures.
   
   The first selection criterion considered selection of all frequently used ingredients concerning the degree of exposures in the workplace. Then, among all frequently found ingredients, we selected the potential sensitizers and irritants (criteria 2). To identify sensitizers and irritants, we conducted a review of the existing literature on human health effects of frequently used ingredients.
   
   All known potential human sensitizers were selected and prioritized in the list; given the concern that sensitization may happen even at very low concentrations.
   
   In the case of irritant ingredients further selection (criteria 3–4) considered their relative potential for workplace exposures, which were considered directly related to the ingredient’s product concentrations and its volatility (relative to other mixture ingredients).
   
   This strategy allowed selection of ingredients that were further evaluated for inhalation and dermal exposure potential using the selected qualitative/semi-qualitative methods.
   
   To address reviewer’s point we have revised this paragraph.

5. Figure 1 lack toilet bowl cleaning, but it is included in Figure 3.
   
   Made necessary corrections!

6. Page 13, in dermal exposure potential, paragraph 2 states that the “graph in Figure 3 “ shows .emission contributes more than transfer or deposition. Does this allude to Table 5? Table 4 shows transfer is the greatest contributor. Figure 3 does not appear to show the contribution of emission transfer and deposition separately.
The sentence appears to speculate on the findings. Perhaps this should be in the discussion, not results.

Yes! These results refer to Figure 2 instead of Figure 3. In addition to this correction we have revised the language to better describe our findings. All the changes are included in the second paragraph on the “dermal exposure potential” section of results. Given the discussion is too long we have decided to keep this paragraph in the results section.

7. Page 14 ingredients that are equal to or greater than 1%, not less than.
   Corrected!

8. Numerous spelling errors (eg. NIOSH, volatilities, Puhorit, field and grammatical errors (absence of articles, agreement, apostrophes).
   …. Corrected!

Discretionary

1. Update TVL reference to 2008
   It was previously updated.

2. Floor care implies inclusion of floor cleaning. I believe this term is used in this article to describe floor finish application and buffing. The term “floor finishing” would be better.
   We have substituted the term “floor care’ with “floor finishing”.

Page 10. “One usage” is not clarified. Is this one room or one floor or one building?
   Corrected!

3. Page 17 Quantitative studies will not elucidate the mechanisms of asthma which more readily would be revealed through biological studies (pathophysiology, IgE vs. IgG mediation, inflammation v. irritation etc.)

   True! But they will facilitate understanding of asthma symptoms through collection of human exposure data. Exposure science is an important piece on understanding disease mechanisms that is usually ignored by toxicologists.

4. Specific Products with trade names are still included in Table 1.

   I have deleted the part of the product name that specifies the manufacture.
Reviewer # 2: Jan_Paul Zock

None!

Reviewer 3: Peder Wolkoff

Major compulsory revisions

The use of the word “hazardous” throughout the manuscript is in my opinion an overstatement. It implies that the chemicals or ingredients already have been doomed as causing adverse effects. In my opinion it would be more correct to talk about: chemicals or ingredients of concern. If the authors continue to use the old terminology, it is mandatory to modify the criteria on page 5 by:

An ingredient was considered to be potentially more hazardous if…

Our group has considered this recommendation as an important clarification of the focus of this exposure assessment study. The term “hazardous” can be misleading to the reader on the distinction between potential for exposure vs. potential for harm. That is why throughout the manuscript, we replaced the words “hazardous ingredients” with “ingredients of concern”.

Minor essential revisions:
Page 3:
The Rosenman and Nielsen references have to be cited, correctly.
We have revised this paragraph.

Page 11, bot :
“Very” low change to low. In the same line: changed
Corrected!

Page 14:
3. Para, line 5: Should it not be: greater than 1% in the product?
Corrected

Page 15:
Last para: write 168 C
“Exposures to its vapors are irritating to eyes, nose and mouth” well, this depends on its actual threshold for sensory irritation, please modify.
For further support about the relevance of 2-butoxyethanol, the authors may consider that information now available to conclude that concentrations above 2ppm may result in sensory irritation in indoor environments (Wolkoff 2008).

We have modified the sentence to: “Indoor exposures to its vapors at concentration threshold of 2ppm (10 mg/m3) and above may result in sensory irritation” (Wolkoff, May 2008).

Page 16
Line 2: NIOSH (Corrected)
2.para, 2 line: insert may, may promote: Inserted.

Page 18: The authors may consider the relevance of the Wainman et. al. (2001) paper since the airway effects of ozone-limonene initiated ultrafine particles have been reported recently (Wolkoff 2008).

We have updated the paragraph with the recently reported the work by Wolkoff 2008.

Page 19:
Line 10: field studies (Corrected)

Table 2:
9 and 10: Ammonium Hydroxide is the same as Ammonia (Deleted Ammonium)

58: Should be tri butoxy …? Yes!

Table 3:
QUATs: benzalkonium chloride is a severe eye irritant. A number of RD50 values or citations (e.g. 2-BE) are missing. They are available from (Schaper 1993), Nielsen et al. 2007). In addition, RD 50 should be defined and explained in text, if incorporated.

We have included the RD50 from the recommended sources. Still there are several RD50 that are missing. Additionally, we explained the definition of RD50 in the legend of the Table 3.