Challenge testing in breathomics

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Challenge tests are widely used in medicine. Such are skin prick tests to réveal allergen, bronchial challenge tests to diagnose initial asthma, glucose tolerance test for early diagnosis of diabetes mellitus, lactose tolerance test etc. Challenge tests load certain body organ systems and reveal their functional limits. It allows to diagnose a disease in early stage. Smoking persons every day challenge their lungs with cigarette smoke containing both cancerogenic chemicals and free radical compounds.

It is well known that smokers most commonly develop such lung diseases as chronic obstructive lung diseases (COPD) and lung cancer. However, these diseases advance slowly and manifest mainly in second half of life. Besides it, some parts of population are predisposed to this danger. To reveal the predisposition we have started a study on smoking individuals using a cigarette smoking as a challenge testrodustiona,

Objectives

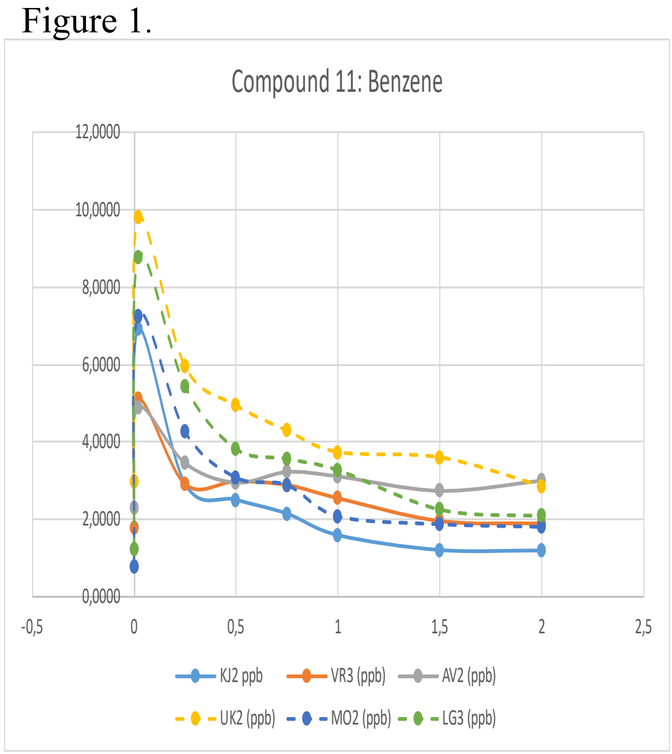
The objectives of this study were to test whwther the pattern of volatile organic compounds (VOCs) concentration changes after the cigarette smoking are reproducible and whether this pattern could predict the individuals resistence aginst the toxic compounds that cotains cigarette smoke

Methods

We analyzed the concentration changes of 35 volatile organic compounds (VOCs) in exhaled air of volunteer smokers before and during two hours period after the smoking event. We performed 62 exhaled air analyses in 17 voluteers of different age, sex, smoking history and lung health status. The smokers group obstained from smoking at least 8 hours before the examination. Exhaled air specimens were taken before, immediately after, each 15 minutes duing the first hour and each 30 minutes during the second hour after the smoking event. Before the air collection lungs were washed by one minute long breathing of pure synthetic air. Specimens were concentrated on adsorption tubes and later analysed by gas chromatography and mass spectrometry.

Results

Figure 1.



The pattern of concentration to time curves were different for particular groups of VOCs.. Individual smokers differed by peak amplitudes and the rate of compounds clearence rate.

Alyphatic linear compounds and aromatic ones like benzene etc. presented with sharp peak immediately after the smoking event followed by slower descending part lasting for approximately one hour. (see fig.1)

As follows from the graphs, individual persons differed by initial level of aromtic compounds (benzene in the figure), by height of initial peak and by decay rate of compound concentration in the exhaled air. Solid lines in the figure reflect three persons with mild obstructive ventilatory failure, indicative for initial chronic ostructive pulmonary disease (COPD). As folows from the figure, persons with obstructive lung failure did not differ from other perons in this group,

Figure 2.

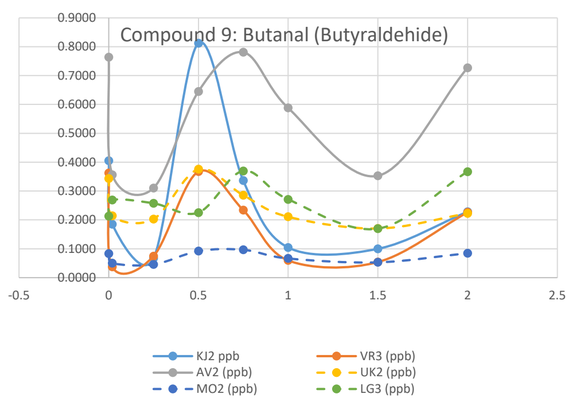
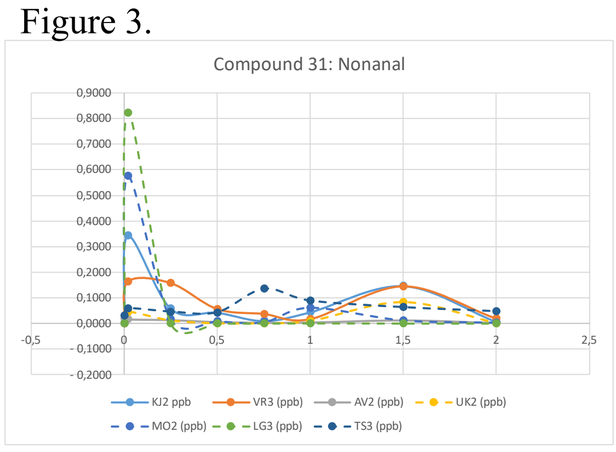


Figure 3.



,Light aldehydes like propanal; and butanal presented with sharp negative deflection folowed by early and late positive peaks The early positive peak started after 15 minutes and reached the maximum after half of an hour, but the late one started after 1.5 hours and reached the maximum after 2 hours (see figure 2.) Line position shows that two of three subjects with ventilatory failure exhaled higher concentrations of the aldehyde.

Heavy aldhydes like octanal and nonanal presented with initial positive peak immediately after the smoking event folowed by late peak 1,5 hours after. Notebly that late peak expressed pnly persons with obstructive lung failure.

Discussion

This study has shown that challenge of lung tissue with tobacco smoke induces the response of body that manifests as the change of the composition of exhaled air. Cigarette smoke contains a huge amont of organic compounds and free radicals that interact with lung tissue, enters the bloodstream through alveolo-capillary barrier affecting blood vessls, reach different internal organs, including liver, where compounds became detoxified by enzyme systems, partially become deposited in the fat tissue and finally become exhaled as a new mixture of volatile organic compounds. Concentration-time chart reflects all the steps of this process.

First short lasting peak evidently represents the evaporation of VOCs from surface film that covers mucosa of respirtory tract. Next steeper concentration decay phase reflects the equilibration between VOCs concenntrations in blood and alveolar air, but late waives reflect the products of body metabolism. rate of VOCs clearence in liver and possibly release from deposition sites, like fat tissue.

Negative initial peaks for light aldehydes could indicate on their fast oxidation by free radicals that contain tobacco smoke. We speculate also that late concentration peaks of aldehydes reflect their ineffective degradation by less potent isoforms of aldehyde dehydrogenases.

Conclusions

We hypothesize that individual pattern of body response to cigarette smoke challenge reflects subjects' metabolic features that lies on the basis of predisposition to certain smoking--induced diseases. As this is a pilot study, further accumulation of data are necessary for confirmation of the hypothesis.