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# ABSORPTION OF INGESTED TALC BY HAMSTERS

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**Summary**—To determine talc absorption in the gastro-intestinal tract of hamsters, talc was neutron-activated and suspended in physiological saline and 1-ml aliquots of this suspension were administered by gastric intubation to six 10-wk-old Syrian golden hamsters, which were kept in metabolism cages. The hamsters were killed 24 hr after gavage, and the skinned carcass, gastro-intestinal tract, lungs, liver, kidneys and collected urine and faeces were analysed for $^{60}Co$ and $^{46}Sc$ by γ-ray spectrometry. An average of approximately 3 mg talc was found in the tissues and excreta. Of this quantity, 74·5% was found in the faeces, 23·5% in the gut and 1·9% in the carcass. The γ-ray counts from the urine, accounting for 0·09% of the total, were probably due to leaching of $^{60}Co$ from the talc with subsequent absorption and urinary excretion. This study shows that intestinal absorption of talc is negligible and could have contributed only minimally to the body burden of talc found in hamsters in a previously published inhalation study (Wehner *et al. Fd Cosmet. Toxicol.* 1977, **15**, 121).

## Introduction

In a previous study (Wehner, Zwicker, Cannon, Watson & Carlton, 1977a), we investigated the effects of inhaled baby powder (talc), using the Syrian golden hamster as an animal model. In the course of the repeated exposure of these animals to a talc aerosol, unknown quantities of talc passed through their gastro-intestinal tract. This talc originated partly from the ciliated part of the respiratory tract, from where it was brought up by the mucociliary clearance mechanism and swallowed, partly from the pelt, on which some powder was deposited during whole-body exposures and from which it was removed by licking, and partly from the hamster feed, on which some talc powder was deposited during exposures. It was necessary, therefore, to determine in our animal model to what degree the gastro-intestinal tract contributes to the body burden of talc.

## Experimental

*Neutron activation of talc.* Johnson's Baby Powder® (lot 228p), hereafter referred to as talc, was exposed to an integrated neutron flux of about $7 \times 10^{16}$ n/cm$^2$, which produced radionuclides by (n, γ) reactions on the major and minor elements in the talc (Wehner, Wilkerson, Cannon, Buschbom & Tanner, 1977b). The neutron-activated talc was allowed to cool for 30 days so that the short-lived neutron-induced isotopes could decay.

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*Animal treatment.* The neutron-activated talc was suspended in physiological saline solution containing 0·6% (w/w) 1% methyl cellulose as the suspending agent. While being agitated by a magnetic stirrer, 1-ml aliquots of the suspension were aspirated with a syringe for administration by gastric intubation to six 10-wk-old female Syrian golden hamsters (*Mesocricetus auratus*, outbred E1a:ENG strain, from Engle Laboratory Animals, Farmersburg, Ind.), maintained in metabolism cages. An additional four (control) hamsters received, also by gastric intubation, 1-ml aliquots of an identical suspension of non-irradiated talc to determine whether the suspending agent or the irradiated talc had a cathartic effect. The hamsters were killed 24 hr after gavage and the skinned carcass, gastro-intestinal tract, lungs, liver, kidneys and collected urine and faeces were analysed for radioactive isotopes by γ-ray spectrometry. The γ-ray counts were compared with those obtained from four control hamsters which had received no talc.

*Analysis of samples.* Tissue samples for γ-ray counting were preserved either in formalin or by freezing. Small tissues such as the lung and kidney were preserved in formalin, placed under a heat lamp to reduce the volume and then transferred to a 7·4-ml polyethylene vial for analysis. Small frozen-tissue samples and faecal and urine samples were transferred directly to vials for γ-ray counting. Large samples, such as the carcass, required high-temperature ashing to reduce the volume for analysis. Previous work in our laboratory has shown that this does not result in volatilization and consequent loss of the radionuc-

Table 1. *Distribution of talc, as indicated by γ-ray counts, in tissues and excreta of hamsters 24 hr after administration of a single neutron-activated dose by gavage*

| Sample | γ-ray counts expressed as | | | | | |
|---|---|---|---|---|---|---|
| | μg talc equivalents | | | % of total recovered | | |
| | Mean* | SD | SEM | Mean* | SD | SEM |
| Gastro-intestinal tract | 688·4 | 232·1 | 94·8 | 23·5 | 10·75 | 4·41 |
| Skinned carcass | 56·0 | 24·8 | 10·1 | 1·91 | 0·73 | 0·30 |
| Lungs | 0·0 | — | — | 0 | — | — |
| Liver | 0·6 | 0·76 | 0·31 | 0·02† | 0·02 | 0·01 |
| Kidneys | 1·2 | 1·19 | 0·53 | 0·04† | 0·04 | 0·02 |
| Urine | 2·6 | 0·66 | 0·33 | 0·09 | 0·05 | 0·03 |
| Faeces | 2187 | 769 | 314 | 74·5 | 11·3 | 4·61 |
| Total talc accounted for... | 2936 | 746 | 304 | | | |

*Derived from a group of six hamsters. All data are corrected for background and control values.
†Not significantly different from control values at the 0·05 level.

lides considered in this study (L. A. Rancitelli, unpublished data 1976).

The γ-ray analyses were performed on several Ge(Li) and Na(Tl) γ-ray spectrometers. Talc standards in geometrical arrangements identical to those of the samples were counted on each system used for sample analysis. Counting times ranged from 100 to 2000 min, depending on the activity in the samples. The quantity of talc in the tissue sample was determined by comparing the sample with the standards.

## Results

The results of this study are shown in Table 1. The γ-ray counts of the hamster tissues and excreta were equivalent on average to a total of 2·94 mg talc. Most (some 98%) of this quantity was found in the faeces (74·5%) and in the gastro-intestinal tract (23·5%). The carcasses accounted for 1·9%. The γ-ray counts of the lungs, kidneys and liver did not differ significantly from those of the controls ($P > 0·05$) but the urine counts, although accounting for only 0·09% of the counts, did. No cathartic effect of the suspending agent or of the activated talc was observed.

Table 2 compares the talc data based on the use of $^{46}Sc$ with that obtained with $^{60}Co$ for the gastro-intestinal tract, carcass and faeces for each animal. The ratios of $^{60}Co$ values to $^{46}Sc$ values are also given and indicate that the $^{46}Sc$ talc data are in reasonably good agreement with the $^{60}Co$ data.

## Discussion

The isotope $^{60}Co$ was used to calculate the quantity of talc in all the samples because it has a long half-life (5·2 yr) and easily detectable coincident

Table 2. *Quantities of talc in tissues and faeces of individual hamsters given a single neutron-activated dose by gavage, as calculated from $^{60}Co$ and from $^{46}Sc$ data*

| Animal no. | Sample | Total talc content (μg)* calculated from counts of $^{60}Co$ (x) | Total talc content (μg)* calculated from counts of $^{46}Sc$ (y) | Ratio x/y ± SD |
|---|---|---|---|---|
| 1 | GI tract | 944 | 1007 | 0·94 ± 0·051 |
| | Carcass | 67·6 | 57·8 | 1·17 ± 0·077 |
| | Faeces | 1332 | 1612 | 0·83 ± 0·050 |
| 2 | GI tract | 294 | 271 | 1·08 ± 0·115 |
| | Carcass | 44·2 | 51·4 | 0·86 ± 0·062 |
| | Faeces | 2232 | 2346 | 0·95 ± 0·012 |
| 3 | GI tract | 615 | 730 | 0·84 ± 0·080 |
| | Carcass | 25·9 | 27·4 | 0·94 ± 0·151 |
| | Faeces | 2007 | 2366 | 0·85 ± 0·015 |
| 4 | GI tract | 869 | 933 | 0·93 ± 0·080 |
| | Carcass | 96·6 | 104·2 | 0·93 ± 0·077 |
| | Faeces | 2637 | 2980 | 0·88 ± 0·014 |
| 5 | GI tract | 633 | 663 | 0·95 ± 0·064 |
| | Carcass | 60·9 | 65·3 | 0·93 ± 0·087 |
| | Faeces | 3417 | 3540 | 0·96 ± 0·014 |
| 6 | GI tract | 775 | 858 | 0·90 ± 0·054 |
| | Carcass | 41·0 | 36·4 | 1·13 ± 0·121 |
| | Faeces | 1495 | 1666 | 0·90 ± 0·059 |

GI tract = Gastro-intestinal tract
*Corrected for control values.

$\gamma$-rays. In addition, $^{46}Sc$ activity was used to estimate the quantity of talc in a number of samples to permit comparison of the sets of talc values obtained with the $^{46}Sc$ tracer and with the $^{60}Co$ tracer. The advantage of using a pair of radioactive tracers to monitor the transfer of talc lies in observing two elements with different dissolution and transfer coefficients in biological systems. If the $^{60}Co$ data and the $^{46}Sc$ data lead to similar talc values, it can be concluded with a high degree of probability that the radionuclides were transferred together by particulates. An alternative situation producing the same $^{60}Co$-to-$^{46}Sc$ ratio in the tissues as was observed in the talc would require these radionuclides to be leached and transferred in identical fashion. The latter possibility is not supported by past experience in our laboratory, which has suggested that biological systems take up Co more readily than Sc (L. A. Rancitelli, unpublished data 1976). To obtain additional information on the degree of radionuclide leaching from talc in body fluids, a leaching study was undertaken in which neutron-activated talc was suspended in bovine serum and in dilute 2N-HCl for various periods of time (Wilkerson, Wehner & Rancitelli, 1977).

A suspending agent was used to prevent rapid sedimentation of the talc particles in the vessel containing the suspension and in the syringe during gavage. Total quantities of talc (mean $\pm$ SEM = 2·94 $\pm$ 0·30 mg) found in the hamsters and their excreta were reasonably uniform.

Most of the talc was recovered in the faeces and gastro-intestinal tract of the hamsters, as was expected. The data show that 24 hr after gavage approximately 75% of the talc had been excreted in the faeces while approximately 23% was retained in the gastro-intestinal tract. Additional residence time in the gut prior to complete elimination of talc-containing faecal matter would probably have resulted in only an insignificant increase in talc absorption, since the passage of 75% of the talc through the gastro-intestinal tract and retention of 23% within it for 24 hr resulted in only 2% absorption. It appears reasonable, therefore, to assume that additional time until complete elimination of the talc from the gastro-intestinal tract would have contributed not more than a small fraction of 1% to the total level of absorption. The zero values for the lung indicate that none of the administered suspension was aspirated by the animals and that no translocation of talc to the lungs took place.

The results of the leaching study mentioned above (Wilkerson *et al.*, 1977) showed that suspending neutron-activated talc in 2N-HCl removed from 0·5 to 1% of $^{60}Co$ and 5% of $^{46}Sc$ from the talc, primarily by leaching. This suggests that leaching of radionuclides from talc may have taken place in the acid environment of the stomach of the gavaged hamsters. Since, according to measurements in our laboratory, this particular talc contained 64 ppm Co, and since 2·94 mg talc passed through the gastro-intestinal tract of the hamsters, 0·5% leaching would have removed from the talc and made available for absorption about 940 pg Co. On the basis of a suggested figure of 30% for absorption from the intestinal tract (ICRP Committee II, 1960), this would have resulted in the translocation of about 300 pg Co to the blood. If leached Co which translocates to the blood is largely excreted in the urine, the excreted $^{60}Co$ should be measurable in the latter fluid. If 300 pg Co were excreted in the urine, the resulting urinary $\gamma$-counts from $^{60}Co$ would be equivalent to roughly 4 $\mu$g talc. Since the measured urine counts were equivalent to 2·6 $\mu$g talc (Table 1), leaching of $^{60}Co$ in the acid environment of the stomach with subsequent absorption from the intestinal tract and excretion in the urine could well account for the quantities of $^{60}Co$ found in the urine.

Apparently 1·9% of the talc passing through the gastro-intestinal tract was absorbed and translocated to parts of the body other than the lungs, liver, kidneys, and gut. Further differentiation of translocation sites was beyond the scope of this investigation.

From the results of this study, it can be concluded that intestinal absorption contributed only minimally to the body burden of talc demonstrated in the hamsters in our previously conducted inhalation study (Wehner *et al.*, 1977a).

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