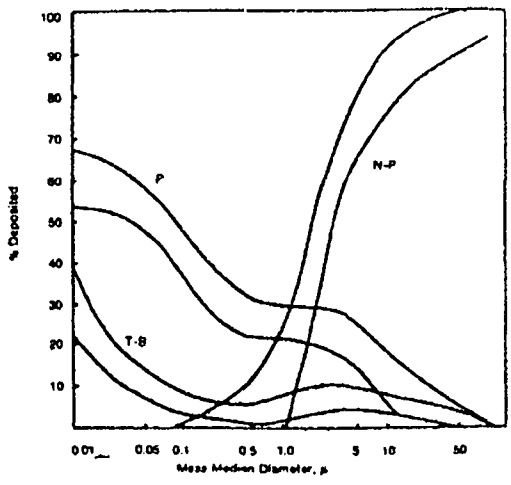


Fig. 3. [From Brain and Valberg (42); reprinted by permission of publisher; copyright 1974, American Medical Association.] Aerosol deposition in respiratory tract. The percentage aerosol deposited was calculated from the assumptions in the model referred to above for a tidal volume of 1,450 ml and a frequency of 15 breaths per min. The profile of deposition of an aerosol is influenced by its effective aerodynamic behavior that (since the distribution of mass for many aerosols is log-normal) may be described by the mass median diameter of the aerosol and its geometric standard deviation. In this figure, per cent aerosol deposited is related directly to the mass median diameter, whereas the 2 lines referring to each lung zone (i.e., N-P, T-B, and P, respectively) indicate the differences in per cent deposition that would result if the geometric standard deviation of the mass median diameter varied from 1.2 to 4.5 μ. N-P = nasopharyngeal surface; T-B = ciliated tracheobronchial surface; P = nonciliated pulmonary surface.

to hours. Mucus and cells from nonciliated airways bearing ingested particles from the major airways are cleared to the pharynx; the material trapped in the nose is also cleared to the pharynx. Here, pulmonary and nasal debris mix with saliva and are swallowed or expectorated (42). This phase of clearance does not appear to be affected by the presence of asbestos lung disease (45) and, under certain circumstances, the effects of smoking in producing bronchitis may even speed this phase of clearance (46, 47).

Particles deposited in the nonciliated regions may be cleared relatively rapidly if they remain on the surface (with a half-time of 24 hours), but once they penetrate fixed tissues, clearance is slowed, with half-times ranging from days to thousands of days (42). It has also been suggested that macrophages decrease the likelihood of fibers penetrating the alveolar walls (42), and that a system of macrophage recruitment meets onslaughts of free fibers and/or particles. Short fibers (< 5 μm) appear to be readily and completely phagocytosed, but long fibers are not, even when attacked by more than one macrophage, which may lead to cell fusion (Allison, 7, p. 89). Clearance of inhaled particles by these mechanisms is believed to be more than 98 per cent effective for most deposited particles (48).

Penetration, Retention, Distribution, and Mobilization of Uncoated Asbestos Particles within the Lung

The use of electron microscopy has revealed the presence of many, many submicroscopic, uncoated asbestos fibers and fibrils in the lung substance of the exposed worker, far more than was ever imagined when the lung fiber population was evaluated by light microscopy alone (49–51). It is also now evident that the proportion of uncoated to coated fibers (i.e., those that form the core of an asbestos body) is very large, of the order of 75 per cent (49), an observation that suggests a very high penetration and retention rate for the submicroscopic particles released into the working environment. Alternatively, these small fibers and/or particles might represent the breakdown products of what were initially larger fibers that had penetrated the alveolar parts of the lung. A second reason for underestimation of the amount of asbestos fiber retained in the lung is the difficulty encountered in its recovery from lungs at autopsy, compared to that of other pneumoconiosis-producing dusts (Nagelschmidt, 5, p. 64). The difficulty in recovery applies more to chrysotile than to other fibers, presumably because of its greater solubility (magnesium, in particular, tends to be leached out) and, hence, its tendency to break down chemically and physically after prolonged residence (51).

Within the lung, there appears to be a tendency for fibers to accumulate in the peripheral regions of the lower zones as indicated by the early appearance of fibrotic reactions in these areas. This distribution has been attributed to posture and gravity effects (Thomson, 9, p. 138).

Most uncoated particles that have penetrated the lung tissue appear likely to remain where they are, particularly if they are intracellular. Some clearance does occur via lymph channels to hilar and mediastinal nodes, where coated and uncoated particles are seen (Hourihane, 5, p. 647), although this appears to be less than