**Women Appear to Have the Same Minimum Alveolar Concentration as Men**

**A Retrospective Study**

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**Background:** A recent report finds that elderly Japanese women given xenon have a significantly smaller (26% less) MAC (minimum alveolar concentration required to eliminate movement in response to surgical incision in 50% of patients) than Japanese men of the same age. The authors assessed whether this finding applied to other/all anesthetics.

**Methods:** The authors reviewed data obtained previously for 258 patients (127 women and 131 men) anesthetized with desflurane, diethyl ether, halothane, methoxyflurane, sevoflurane, or xenon. Data were normalized to the MAC for the anesthetic as determined by logistic regression (i.e., MAC would equal a value of 1.000.)

**Results:** The MAC for the normalized combined (all) data for women (1.013 ± 0.017; mean ± SEM) did not differ significantly from the normalized combined data for men (1.005 ± 0.009), and neither differed significantly from 1.000. However, a significantly smaller MAC value was found for women in two studies of sevoflurane (subsets of the above studies) given to Japanese patients: 12% in one study and 16% in the other.

**Conclusions:** Overall, no difference in MAC was found for women versus men. Whether women (particularly older Japanese women) have a smaller MAC than men remains to be confirmed by prospective studies.

DOES gender influence the minimum alveolar concentration of an inhaled anesthetic required to eliminate movement in 50% of subjects given a noxious stimulus (MAC)? Goto et al.¹ used several arguments to suggest that MAC for nonpregnant women, particularly MAC for xenon, would be less than MAC for men. Consistent with their arguments, they found that the MAC for xenon for elderly women (71 ± 5 yr; mean ± SD) was 26% less than MAC for elderly men (70 ± 3 yr). The MAC values were 51.1 ± 3.2% xenon (mean ± SEM) for 24 women versus 69.3 ± 3.2% for 24 men (P < 0.01 by unpaired t test.)

Studies in animals have not demonstrated that male animals differ in their MAC from female animals that are not pregnant. Isoflurane MAC for 129J female mice did not differ from the MAC for male mice.² Similarly, we found (unpublished data, Edmond Eger, M.D., Michael Laster, D.V.M., James Sonner, M.D., San Francisco, California, 2001) that MAC for desflurane, halothane, and/or isoflurane does not differ in three strains of mice. Other investigators found that MAC does not differ for halothane, isoflurane, and enfurane in male versus female Sprague-Dawley rats and Swiss Webster mice.³ These investigators also found that pregnant rats and mice do not have MAC values different from those of nonpregnant female rats and mice, whereas other investigators report a lower MAC in pregnant than nonpregnant rats.⁴

Chronic progesterone administration can decrease MAC⁵ and induce sleep in women,⁶ but Tanifuji et al.⁷ found that MAC did not differ in women as a function of their menstrual cycle, despite large differences in plasma progesterone. Other studies demonstrate that pregnancy in some animals⁸,⁹ and in humans,¹⁰ including early pregnancy,¹¹ or immediately postpartum,¹² can decrease MAC. Gender does not affect the concentration of sevoflurane or isoflurane that allows awakening (MACawake) in humans.¹²

Whether gender influences MAC, particularly in nonpregnant humans, therefore remains unclear. We thus asked whether the findings of Goto et al.¹ for xenon in elderly patients apply to other anesthetics. Specifically, we tested the hypothesis that MAC in men exceeds MAC in nonpregnant women.

**Materials and Methods**

Data were retrieved for 258 patients (127 women and 131 men) from previous studies of MAC for desflurane and desflurane with 60% nitrous oxide,¹³ diethyl ether,¹⁴ halothane (several studies),¹⁵,¹⁶ methoxyflurane,¹⁴ sevoflurane (three studies),¹⁷⁻¹⁹ and xenon.¹⁵ The investigators for each of these had obtained approval for human studies as appropriate for the time period of the study. We limited the data taken from the various studies to patients who had been given 2.1 MAC or less. We also (arbitrarily) excluded data from studies in which either sex constituted less than 29% of all subjects.²⁰,²¹

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A MAC value for each of the anesthetics had been calculated and published by the investigators for each of the above reports (table 1). Because the methods for determination of specific MAC values varied from report to report, we recalculated the MAC value for the combined (women plus men) data for each report using logistic regression.

Then, again using logistic regression, we separately determined the MAC for women and men from each report. In a few cases, we could not determine the MAC and variance using logistic regression because the concentrations for movement did not overlap those for nonmovement. In many of these, we could determine MACs and SEMs by nonlinear regression because the concentration data were normalized by dividing the concentration by a constant. We combined the MAC and variance for women and men and then used logistic regression to determine the MAC value for each of the anesthetics. We then calculated MAC values for individual patients by the combined MAC for both women and men for that anesthetic for a given report (e.g., three separate MAC values were used in the case of sevoflurane) as determined by logistic regression. We separated the data for desflurane plus 60% nitrous oxide from the remaining data and did not perform further analyses for the desflurane plus 60% nitrous oxide data because we did not wish to assume a desflurane equivalent for the nitrous oxide used. We combined the remaining normalized data for women and for men and used logistic regression to determine the MAC value (here, MAC becomes a value of 1.0, i.e., a normalized value) and SEM for men and (separately) women. The difference in the MAC values for gender within a given anesthetic, and the difference in the MAC values for the combined data for each sex were compared by use of an unpaired 2-tailed Student’s t test with no correction for multiple comparisons. We accepted P < 0.05 as indicating a significant difference.

### Results

MAC values determined by logistic regression were virtually identical to the previously published values, differing by 0.3 ± 2.9% (mean ± SD for 14 values, table 1; no difference was statistically significant.) In 2 (both sevoflurane) of 10 comparisons, the MAC for men significantly exceeded the MAC for women. In no comparison was the value for men significantly less than the value for women. The MAC for the normalized combined (all) data for women (1.013 ± 0.017; mean ± SEM) did not differ significantly from the normalized combined data for men (1.005 ± 0.009) (fig. 1) (MAC itself would equal a value of 1.00). Considering all data except those for sevoflurane, the normalized MAC for men (0.999 ± 0.009) did not differ from that for women (1.030 ± 0.019). However, considering only the data for sevoflurane, the normalized MAC for men (1.052 ± 0.015) significantly (P < 0.01) exceeded the MAC for women (0.957 ± 0.025), women having a value 9% less than men.

### Discussion

Overall, we found no difference in the MAC for women versus men. However, consistent with the report by Goto et al., we found two instances in which the MAC for men significantly exceeded the MAC for women (table 1). Both of these were for sevoflurane, and both were obtained in Japanese patients. The differences between men and women found by Katoh et al.
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References


