PREANESTHETIC MEDICATION FOR CHILDREN
COMPARISON OF ORAL AND INTRAMUSCULAR ROUTES

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ANESTHESIOLOGISTS often see children who have an excessive fear of hypodermic injections, become fearful and tremulous when told such an injection will be given, and may even exhibit panic and need forcible restraint. In the belief that premedication given orally to these children might result in more cooperative and less suspicious and apprehensive patients, studies were undertaken to compare the effectiveness of intramuscular and oral administration of preanesthetic drugs.

METHOD

Four hundred and eighty-one children (3 weeks to 10 years of age) were observed before and during operation. The patient's age and weight; dose, time and route of premedication; type of anesthetic and operation; whether or not crying occurred and restraint was needed during induction; and complications were recorded. When possible, pulse and respiratory rates were recorded before induction, during ether anesthesia, and during and after operation. Observations were not made before premedication was given.

All patients received ether anesthesia, preceded in most by divinyl ether induction. In a few cyclopropane was introduced under the open-drop mask to facilitate induction, and in others a nitrous oxide-oxygen-ether sequence was used. The most frequent operation was tonsillectomy and adenoidectomy; few patients had major surgery.

Meperidine was selected for premedication (1 mg./pound of body weight, orally) because a potent preparation was available that was compatible with scopolamine and atropine and which retained palatability after addition of these drugs. A control series using intramuscular meperidine and scopolamine was observed for comparison with the series receiving oral premedication. The dosage was based on the weight of the child, without regard for age, surface area or obesity. Table 1 shows the doses of meperidine (0.66 mg./pound) and scopolamine (0.006 mg./pound) for each 10 pound differential.

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RESULTS

Optimum Drying Effect. Drying effect of the belladonna drugs was graded as excellent, good, fair, or poor depending upon the quantity of secretions noted by the anesthetist from induction of the anesthesia to the beginning of operation: excellent—no evident secretion; good—minimal secretion, not requiring suction; fair—moderate secretions, requiring suction once or twice, but not interfering with induction; and poor—excessive secretions.

INTRAMUSCULAR MEPERIDINE-SCOPOLAMINE: In 174 patients, scopolamine, ranging in dose from 0.004 to 0.008 mg./pound, produced consistently effective drying of secretions when administered intramuscularly from 15 to 120 minutes prior to induction. Six patients received their premedication 15 minutes and 2 patients, 10 minutes before induction. Twenty-five other patients were given premedication from 15 to 30 minutes before induction. Adequate drying occurred in both groups. Insufficient numbers of patients were given premedication more than two hours preopera-

TABLE 1

INTRAMUSCULAR PREMEDICATION

Weight Range (pounds)	Meperidine Dose in mg. (approximately 0.66 mg./pound)	Scopolamine Dose in mg. (approximately 0.006 mg./pound)
under 15	0	0.06
15–24	15	0.12
25–34	20	0.18
35–44	25–30	0.24
45–54	35	0.30
55–64	40	0.36
65–74	45–50	0.42
over 75	50	0.42

TABLE 2

DRYING EFFECTS OF INTRAMUSCULAR MEPERIDINE AND SCOPOLAMINE CLASSIFIED BY WEIGHT. AVERAGE SCOPOLAMINE DOSE 0.006 MG. PER POUND

Weight (pounds)	Scopolamine Dosage Range (mg. per pound)	Total	Excellent Number (Per Cent)	Good Number (Per Cent)	Fair Number (Per Cent)
Under 15	0.0045–0.008	19	15 (79)	2 (11)	2 (11)
15–24	0.004 –0.008	16	13 (81)	2 (13)	1 (6)
25–34	0.0045–0.008	39	34 (87)	3 (8)	2 (5)
35–44	0.0045–0.007	41	37 (90)	2 (5)	2 (5)
45–54	0.004 –0.008	38	30 (79)	7 (18)	1 (3)
55–64	0.0045–0.0065	13	11 (85)	1 (8)	1 (8)
65–74	0.006 –0.0065	8	4 (50)	3 (38)	1 (13)
Totals	0.004 –0.008	174	144	20	10
Per Cent		100	83	12	6

tively to determine the maximum duration of effectiveness of scopolamine. Table 2 classifies these patients into weight groups. No significant differences in effectiveness among these groups is apparent. No failures (poor) occurred and over 94 per cent of the results were excellent or good.

ORAL MEPERIDINE-SCOPOLAMINE (Table 3): As the dosage of scopolamine administered orally was increased from 0.006 to 0.025 mg./pound, in increments of 0.003 to 0.007 mg./pound, there was a decreasing number of failures. At 0.012 mg./pound dosage, there was a statistically significant increase in excellent and good results. Increasing the dose to 0.015, 0.018, and 0.025 mg./pound produced little further improvement in drying effect except that the number of failures showed a moderate decrease which was not statistically significant. At the dosage of 0.025 mg./pound, failure occurred in 4 per cent, while 80 per cent of the results were excellent or good.

ORAL MEPERIDINE-ATROPINE (Table 4): There was a moderate decrease in incidence of failure to produce drying as the oral atropine dose was increased from 0.012 to 0.025 mg./pound, in increments of 0.003 to 0.008 mg./pound. This decrease was not statistically significant. Failures occurred in 8 per cent of the patients at a dosage of 0.025 mg./pound, and in 86 per cent excellent or good results were observed.

Side-Effects. Two untoward side-effects of the administration of belladonna drugs are tachycardia and delirium.

TACHYCARDIA: Some degree of tachycardia is usually seen in children anesthetized with ether. It is thus difficult to assess the role of belladonna in reference to this increase in pulse rate. The significant difference in average pulse rates, however, between the oral or intramuscular scopolamine and oral atropine (table 5) indicates that oral atropine, in doses sufficient to produce drying of secretions, has a greater cardiac vagolytic effect than oral

TABLE 3

DRYING EFFECTS OF ORAL SCOPOLAMINE MIXED WITH MEPERIDINE, 1.0 MG. PER POUND

Scopolamine, mg. per pound	Total	Excellent	Good	Fair	Poor	Per Cent Good and Excellent	Per Cent Poor
0.006	9	3	0	2	4	33))*a*	44
0.009	19	5	3	7	4	42)	21
0.012	21	12	5	2	2	81))	9.5
0.015	46	19	14	7	6	72))*b*	13
0.018	17	8	3	5	1	65))	6
0.025	51	34	7	8	2	80)	4
Totals	163	81	32	31	19	69	12

The difference between *a* and *b* is highly significant (at the 0.1 per cent level by the chi square test). The difference between 0.012 and higher doses of scopolamine is not demonstrated to be statistically significant, i.e., the differences observed might be due to chance.

TABLE 4

DRYING EFFECTS OF ORAL ATROPINE MIXED WITH MEPERIDINE, 1.0 MG. PER POUND

Atropine, mg. per pound	Total	Excellent	Good	Fair	Poor	Per Cent Good and Excellent	Per Cent Poor
0.012	11	3	3	3	2	55	18
0.016	34	17	7	5	5	71	14
0.020	19	8	4	2	5	63	26
0.025	49	32	10	3	4	86	8
Totals	113	60	24	13	16	74	14

The differences between drying effects at the varying dosage levels are not demonstrated to be statistically significant, i.e., the differences observed could be due to chance.

scopolamine administered in doses producing a comparable drying effect. Moreover, oral scopolamine in doses of 0.025 mg./pound produced no significant change in pulse rate compared with intramuscular scopolamine in doses approximately one fourth as large.

DELIRIUM: Of 149 patients to whom intramuscular meperidine and scopolamine were administered, 3 were irrational prior to induction. No delirium was noted in 55 patients who received oral meperidine and atropine. Of 56 patients who received oral meperidine and scopolamine, one was recorded as irrational. Although delirium may occur following administration of scopolamine in toxic doses or in the presence of pain, it is apparently an uncommon occurrence when scopolamine is administered in therapeutic doses either intramuscularly or orally.

TABLE 5

AVERAGE PULSE RATES

Type and Dose of Premedication	Average Pulse Rates*	
	Before Anesthesia	During Surgery
Intramuscular		
Meper. 0.66 mg./pound		
Scop. 0.006 mg./pound	116 (14)	136 (102)[a]
Oral Meperidine-Scopolamine (mg./pound)		
0.009	101 (8)	127 (16)
0.012	114 (4)	136 (16)
0.015	99 (7)	130 (29)
0.018	—	130 (13)
0.025	117 (18)	143 (26)[b]
Oral Meperidine-Atropine (mg./pound)		
0.012	108 (1)	145 (4)
0.016	131 (4)	152 (13)
0.020	132 (2)	154 (7)
0.025	143 (16)	165 (23)[c]

* Figure in parentheses indicates number of patients observed.

ab—Difference not statistically significant; $p < 0.1, > 0.05$.

ac—Difference highly significant; $p < 0.01$.

bc—Difference highly significant; $p < 0.01$.

Meperidine Dosage and Effect. Observations of respiratory rates during anesthesia demonstrated (table 6) that meperidine-scopolamine intramuscular premedication significantly reduced average respiratory rates below those observed following secobarbital-scopolamine intramuscular premedication. Using these rates as a basis of comparison, the relative effectiveness of the meperidine doses were assessed for intramuscular and oral routes. Average respiratory rates were slightly higher following oral administration of meperidine, indicating a somewhat greater effectiveness of the drug administered intramuscularly.

Respiratory depression was observed in two forms; a rate so slow that induction appeared to be lengthened, and apnea or hypoventilation occurring unexpectedly in relatively light anesthesia. This latter occurrence, while not rare, responded well to lightening of the depth of anesthesia. Following intramuscular administration of meperidine and scopolamine, moderate respiratory depression occurred during anesthesia in 14 of the 138 patients (10 per cent). Three instances of respiratory depression were noted in the 117 patients

TABLE 6

AVERAGE RESPIRATORY RATES FOLLOWING INTRAMUSCULAR PREMEDICATION: SECOBARBITAL AND MEPERIDINE

Type of Premedication	Average Respiratory Rates*			
	Before Anesthesia	During Induction	During Surgery	After Surgery
Secobarbital-Scopolamine	28 (9)	36 (29)[a]	39 (31)[c]	28 (3)
Meperidine-Scopolamine	22 (22)	26 (86)[b]	26 (93)[d]	23 (68)

* Figure in parentheses indicates number of patients observed.
ab—Difference highly significant; $p < 0.01$.
cd—Difference highly significant; $p < 0.01$.

given oral meperidine and atropine (2.6 per cent), and 4 in the 161 patients given oral meperidine and scopolamine (2.5 per cent). This difference in incidence of respiratory depression following intramuscular and oral meperidine is significant at the 1 per cent level by the chi square test.

Sedation. One hundred and twenty-one patients (2 to 10 years of age) who had received intramuscular meperidine-scopolamine were evaluated according to their response to induction. Children who neither cried nor required restraint, until the involuntary excitement stage, were graded "satisfactory." Those who cried and needed restraint were graded "unsatisfactory," although most of the voluntary excitements were not severe. One-half (57 per cent) of inductions in the 2 and 3 year old children were graded "unsatisfactory," while only 18 per cent of the 4 to 6 year olds were so graded. There were no "unsatisfactory" inductions in the 31 children from 7 to 10 years of age. Since most of these children were awake and rational at the time of induction, it seemed that adequate psychic management is more important than preoperative medication in preparing children over 3 years of age for "satisfactory" inductions. On the other hand, attempted psychic preparation and management is less effective in 2 and 3 year olds. In this age group more preoperative sedation is required to avoid "unsatisfactory" inductions.

Hypnotic Effect. The hypnotic effect of premedication, while less frequently exhibited than the sedative effect, was easier to evaluate. A calm, cooperative state resulting from good psychic preparation was indistinguishable from a similar state produced by chemical sedation. On the other hand, when a hypnotic effect occurred, it was usually from the premedication, and comparisons of the different premedication routines were readily made. Scopolamine was more effective in producing a hypnotic effect than meperidine—6 per cent incidence after oral meperidine-atropine, compared with 21 per cent after oral meperidine-scopolamine. This difference was statistically significant at the 1 per cent level by the chi square test. Intramuscular meperidine-scopolamine produced a similar incidence of hypnotic state, 23 per cent.

Advantages of Oral Premedication. The oral premedication was easy to prepare and administer and was accepted by most children. The majority of children found the taste pleasant and preferred it to a "shot." The psychic advantage can only be inferred by our knowledge of the adverse reaction of some children to hypodermic injections. The child who panics, screams, and requires restraint during his preoperative injection might be expected to be more suspicious and uncooperative during induction of the anesthesia than if oral medication had been used. Moreover, when children are being given premedication in a group, such screaming may add to the apprehension of the other children waiting their turn. Oral premedication helps to create a quieter atmosphere when groups of children are involved.

Disadvantages of Oral Premedication. When the rare refusal of oral medication occurred hypodermic medication was substituted. Three children developed emesis shortly after administration of oral medication, and the amount of the drug lost in the emesis was uncertain. The inadequate drying effect noted in these patients was probably related to this loss. This disadvantage can be overcome by prompt addition of hypodermic premedication, if the emesis occurs less than 30 to 45 minutes after oral medication. The only major disadvantage of oral premedication observed in this study was the increased inci-

TABLE 7

ANALYSIS OF INCIDENCE OF EMESIS DURING INDUCTION IN RELATION TO PREMEDICATION

Type of Premedication	Number of Cases	Emesis During Induction	
		Number	Per Cent
Intramuscular Scopolamine 0.004 to 0.008 mg./pound	174	4	2.3[a]
Oral Scopolamine 0.006 to 0.018 mg./pound with elixir of meperidine	118	21	18[b]
Oral Scopolamine 0.025 mg./pound with syrup of meperidine	47	1	2[c]
Oral Atropine 0.012 to 0.020 mg./pound with elixir of meperidine	49	4	8[d]
Oral Atropine 0.025 mg./pound with syrup of meperidine	49	1	2[e]

ab—statistically significant; $p < 0.01$.
ad—not statistically significant; $p > 0.05, < 0.1$.
bc—statistically significant; $p < 0.05$.
bd—not statistically significant.
de—not statistically significant.

dence of emesis during induction compared with a 2.3 per cent incidence after intramuscular premedication. Since these instances of emesis occurred during light anesthesia, the patients, in most cases, expectorated gastric contents without assistance. There was no clinical evidence of aspiration.

Table 7 indicates the significant increase in incidence of emesis when oral scopolamine in doses of 0.006 to 0.0018 mg./pound was administered with the elixir of meperidine. Atropine when administered orally with the elixir produced no significant increase in incidence of emesis. Because the alcohol in the elixir of meperidine might stimulate gastric secretion and be responsible for the increased incidence of emesis, a syrup of meperidine was prepared and used for the remainder of the study. When both atropine and scopolamine were added to the syrup of meperidine in a dose of 0.025 mg./pound, the incidence of emesis was reduced to 2 per cent (table 7). Hypodermic medication with derivatives of belladonna was effective within 15 minutes after administration, while oral medication was unsatisfactory if administered less than 30 minutes before induction.

DISCUSSION

Intramuscular scopolamine (0.004 to 0.008 mg./pound) was found to be effective without significant toxic effects. The dose may be reduced to 0.004 mg./pound without significant reduction in effectiveness. Some failures occurred at a dose of 0.003 mg./pound; therefore, 0.004 mg./pound can be considered the lowest limit of effective dosage for intramuscular scopolamine in children under 75 pounds. When scopolamine was administered orally, a significant rise in drying effect occurred when the dose was increased to 0.012 mg./pound (twice the intramuscular dose). Ten per cent failures occurred with this dose compared with no failures with intramuscular scopolamine. Further increase in oral scopolamine to 2½, 3, and 4 times the intramuscular dose produced moderate improvement, but never were the results as good as those with the intramuscular route.

In this study, oral scopolamine was superior to oral atropine in two respects, decreased incidence of tachycardia and increased sedative-hypnotic effect. Scopolamine appears to be the drug of choice for oral premedication unless one of the synthetic anticholinergic drugs proves to be a more consistent drying agent or to have a more favorable oral to intramuscular dosage ratio. Since meperidine is only "fair" in allaying apprehension in pediatric patients, some of the sedative hypnotics or tranquilizing drugs might be more useful in this regard. Secobarbital (1.5 mg./pound, intramuscularly) has been used to produce adequate sedation without respiratory depression.

Emesis was the major complication of oral medication. In the first part of the study, the increased incidence of emesis appeared to be related to inadequate belladonna drying effect and the alcohol in the oral medication. In the latter part of the study, doses of the derivatives of belladonna were increased and the alcoholic content of the vehicle was eliminated. In this group the incidence of emesis during

induction was as low as with intramuscular premedication. It is not known which of these changes (or both) was responsible for the improvement. It was not determined if the volume of gastric juice was significantly increased by oral medication.

Summary

The effects of oral preanesthetic medication with meperidine and scopolamine or atropine were compared with intramuscular meperidine and scopolamine in children. Intramuscular scopolamine was effective as a drying agent in a dose of 0.006 mg./pound, while scopolamine and atropine were usually effective orally in doses of 0.025 mg./pound.

Oral meperidine, 1.0 mg./pound, produced less respiratory depression than intramuscular meperidine in a dose of 0.66 mg./pound. A more satisfactory intramuscular dose, therefore, might be 0.5 to 0.6 mg./pound, with the ratio of oral to intramuscular dose, approximately 2 : 1.

Sedation was usually mild and less apparent after meperidine than after scopolamine premedication. The incidence of crying and the need for restraint during induction varied with the age of the child. The mild sedation was satisfactory for over 85 per cent of the children over 3 years of age. For children 2 and 3 years old, over one-half of the inductions were unpleasant, and it was concluded that these children required heavier preanesthetic sedation.

Oral premedication was easy to administer, acceptable to most children, and the taste was satisfactory. An increased incidence of emesis with oral medication was reduced by a change in the vehicle and an increase in the dose of derivatives of belladonna.