

The effect of a large dose of atropine upon the performance of routine tasks

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1. A field trial was conducted in order to assess the effect upon tasks, including hard labour, skilled work, the use of instruments and tools and shooting, of giving 6 mg of atropine sulphate by injection to twenty-three adult male volunteers.
 2. Impairment of performance was seen in these tasks under the influence of the drug, but this was statistically significant only in some of them.
 3. Drowsiness occurred in twenty-one men and perceptual disorders were common, but two men were almost completely resistant to the effects of the drug.
 4. The implications of the therapeutic use of comparable doses of atropine are discussed.
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The use in agriculture and industry of organophosphorus compounds, and their possible use in warfare, has led to the need for treatment of poisoning by these substances with doses of atropine far greater than those usually given for other purposes (Special article, 1952). Because treatment may, on occasion, be given in the absence of organophosphorus poisoning as a result of mistaken diagnosis, and especially because workers in isolated places may sometimes be issued with self-injection devices, it was considered necessary to investigate the effects of large doses of atropine in man.

Methods

Twenty-three fit male volunteers from the Army were dressed in anti-gas clothing and battle equipment, and undertook a series of tests on each of 3 successive days in June 1967, in which they marched for 30 min, dug themselves into individual "foxholes", and performed tests of skills appropriate to their particular military duties.

On the first of these 3 days the subjects received a placebo injection intramuscularly consisting of a sterile isotonic solution of glycerine and borax, three times at intervals of 20 min; on the second day three injections of 2 mg of atropine sulphate were given so that the subjects received 6 mg in all; on the third day no injections were given. Injections began 15 min after the start of the march. It was

not considered practical to attempt to use a crossover design for the experiment. Except for two medical officers, who were informed for safety reasons, neither the subjects nor the observers were informed on which day the drug was to be given.

Each man's rectal temperature was monitored on the second day as a safety precaution, but it was only possible to monitor temperatures in 5 men on the first day. An adequate fluid intake was ensured, but it was not possible to keep fluid balance records in the field.

The weather was mild on days 1 and 3 (control and recovery days), when the mean air temperatures were 16.1°C (± 0.73) and 17.7°C (± 0.40) respectively; on day 2 (treatment day) the mean air temperature was 18.8°C (± 1.88).

Special tests of skill included a simple arithmetic exercise: the Number Facility Test (Moran & Mefferd, 1959) in which all the subjects took part, once shortly after digging began and again during the early afternoon; field medical test, in which one medical officer and four other medical personnel searched for two casualties in a wood, treated them and transported them to a nearby ambulance; test of map reading and taking compass bearings, which was undertaken by five infantrymen; rifle shooting test, which was given to seven infantrymen, and a test in which six drivers were timed while they each changed one wheel of a Land Rover. The tests of special skill were administered twice on each day, once after the morning digging, which lasted 1 hr 20 min, and was followed by lunch from a field ration pack, and once after digging for 1 hr in the afternoon.

With the exception of the field medical team, whose performance as a team was marked on a ten point scale by a medical officer, each test of skill was marked by two judges. The Number Facility Test was marked according to the standard method of scoring this test, the map and compass reading test was marked by giving points for correct answers to ten questions on the map and subtracting points for errors made in using the compass, while the wheel changing test was scored for the time taken to complete the test, with general observations on the clumsiness or otherwise with which the task was performed. The rifle shooting test was marked in the first place by scoring for performance in grouping the shots, but as will be seen, the main effect of atropine on this test proved to be a difference in the placing of the groups, rather than in the size of the groups, so that qualitative observations were considered more appropriate.

The detailed timetable of the trial on each day is given in Table 1.

TABLE 1. *Timetable of actions on each day of the trial*

09.30	Dress in anti-gas clothing after insertion of rectal probe (when worn). Draw field rations. Assume full battle equipment.
10.30	Start march.
10.45	Halt. Put on respirators. First injection (day 1 and 2).
10.50	Continue march.
10.55	Halt. Remove respirators. Continue march.
11.00	Arrive at digging point. Collect digging tools.
11.05	Second injection. Begin digging.
11.25	Third injection. Number facility test. Resume digging.
12.25	Stop digging. Tests of special skills.
13.10	Lunch from ration pack.
13.40	Resume digging.
13.50	Number facility test. Resume digging.
14.40	Stop digging. Tests of special skills. Return in motor transport to billets.

Results

In general there was a falling off in alertness, efficiency and energy, as judged by the observers, on the day on which atropine was given, which appeared to begin at the time of the third injection (40 minutes after the first). Functional recovery seemed complete on the third day of the trial. Subjective recovery, as indicated by the subjects feeling well and believing that they had recovered from the effects of the drug, occurred between 4 and 21 hr after the first injection (mean 9.2 hr), except for two men who experienced minor discomfort for no more than half an hour and recovered completely thereafter. Mydriasis occurred in all subjects, except for the two who were almost unaffected, and was still perceptible 48 hr after the injections.

Rectal temperatures did not rise higher under the influence of atropine than those observed among the subjects monitored on the first day, except for one man who worked hard, and who was stopped from digging when his temperature reached 103° F (39.4° C); the other men slackened off their digging as their temperatures rose on the day of the atropine injections and many stopped work for a time.

Disorders of perception occurred in ten of the subjects after receiving atropine, and included frank visual and auditory hallucinations (one man), minor visual hallucinations such as seeing coloured flashes of light (seven men) and two gustatory hallucinations in which the men reported that fresh water tasted salt. One man became disorientated and ataxic and was withdrawn from the second day's trial 1 hr after the third injection of atropine, but recovered without treatment 8.5 hr later. All but the two men who were almost unaffected were more or less drowsy, and ate only small amounts of lunch.

Performance of the digging task, in which the volume of earth dug was measured for each subject at the end of each day, was significantly reduced on the second day compared with that on the first day (Student's *t* test indicates $P < 0.001$), but recovery was complete on the third day.

The Number Facility Tests show no impairment of performance on the morning of the second day, when they were carried out immediately after the third injection of atropine, but a highly significant impairment ($P < 0.001$) in the afternoon, when 3.25 hr had elapsed between the third injection and the test; five men were unable to attempt the test at all on the second afternoon; two of these complained that the figures had left the paper and were floating in mid air. Recovery was complete on the third day.

TABLE 2. Mean or team scores obtained in the tests (standard deviations in brackets)

Test	Scoring	First day		Second day		Third day	
Digging*	Cubic feet per day	16.94 (4.82)		8.29 (4.78)		17.60 (2.69)	
Number facility*	No. of sums correct	a.m. 23.78 (9.10)	p.m. 28.35 (9.15)	a.m. 23.74 (10.67)	p.m. 16.50 (14.61)	a.m. 27.27 (9.97)	p.m. 41.32 (66.04)
Medical test†	Team points	6	8	2	3	6	8
Map and compass‡	Points	2.40 (6.80)	0.90 (5.35)	-8.20 (9.33)	-3.35 (7.31)	2.88 (5.45)	-2.25 (6.60)
Wheel changing‡	Minutes	5.80 (1.72)	4.93 (1.28)	7.16 (2.35)	7.60 (5.73)	4.59 (1.55)	3.72 (1.10)

**n* = 23. †*n* = 5. ‡*n* = 6.

The field medical team carried out their tests clumsily and less efficiently under the influence of atropine than on the first or third days. In particular, a casualty with simulated extensive burns of one leg was allowed to walk 100 yards to the ambulance, and the medical officer, when questioned afterwards, did not remember the incident.

The map and compass reading tests, in which points were awarded for correct map reading and subtracted for errors in compass work, so that a negative score was sometimes recorded, show a significant reduction in score ($P < 0.01$) in the morning of the second day compared with that of the first, a non-significant decrease in score occurred in the afternoon, and recovery had occurred by the morning of the third day, but performance of this test was poor in all the afternoons of the trial.

Rifle shooting, which was marked individually for grouping performance, did not show any marked difference between scores obtained under the influence of atropine and those on the first or third days, but the men placed their shots on the opposite quadrant of the target from that on which they grouped on the first day.

The wheel changing test took longer to do under the influence of atropine than on the first or third days and was performed more clumsily, but the difference in times taken was not significant.

Mean scores, or team scores for all tests, except for the shooting test, where the difference in performance was not indicated by the scores, are shown in Table 2, with standard deviations in brackets where applicable.

Discussion

Reports of the experimental use of large doses of atropine are few, but Cullumbine, McKee & Creasey (1955) reported the autonomic effects of doses of atropine up to 5 mg per man in laboratory experiments and reported dizziness, drowsiness, difficulty in reading and dysuria after such doses of the drug. Chamberlain, Turner & Sneddon (1967) report the effect of increasing doses of atropine on cardiac function in the laboratory, using an autonomic blocking agent. In this trial the effect of 6 mg of atropine has been assessed in the situation in which men, having taken this dose of the drug as a result of mistaken diagnosis, continue to perform manual labour or skilled tasks, as might possibly happen in industry or would be more likely to happen in war.

In the activities tested, an impairment of performance after the use of 6 mg of atropine was found, although this was statistically significant in some cases only. In the case of manual labour, it seems that the task would either be abandoned or greatly delayed, but if circumstances such as warfare or an industrially dangerous situation forced the drugged men to continue working hard, heat casualties may be expected, especially if any form of protective clothing is worn.

Tasks involving skill, and especially those involving the use of tools or instruments, were performed on the whole more slowly and less efficiently under the influence of atropine, and decisions made by those in charge of others (for example, the medical officer) took longer to make and were sometimes wrong. The effect of the drug on the shooting test, however, does not suggest that shooting was unco-ordinated so much as that the effect of atropine on vision caused these men to sight their targets in a different manner, focusing their eyes differently upon the foresight,

and this impression is strengthened by the fact that the mydriasis produced by the drug and the different placing of the marksmen's groups on the targets were both still present on the third day of the trial.

Apart from the effect of atropine on the shooting test, recovery of performance was complete 24 hr after the drug was administered, and the subjects reported that they felt well after a time which varied between 4 and 21 hr, except for two individuals who seemed to possess a high degree of resistance to the effects of 6 mg of atropine.

I thank the Director General of Medical Services of the Royal Air Force for permission to publish this work, and Dr. W. S. S. Ladell and Dr. F. W. Beswick, of the Chemical Defence Establishment, for much helpful advice and criticism.

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(Received February 14, 1969)