

Sharpening surgical skill: effects of alcohol and sleep deprivation on dexterity.

Report to the Alcohol Education and Research Council

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Pressure to change

The training of surgeons has traditionally been an apprenticeship. Trainees learn to undertake surgical procedures by first observing, next assisting, then performing under supervision and finally performing alone. This is an efficient and safe method provided it is properly supervised, but there may be some skills that are better learnt in the training laboratory rather than in the operating theatre. The advent of minimal access or laparoscopic surgery has given particularly strong impetus to the development of new training and assessment methods. Minimal access surgery demands high dexterity and novel skills from the surgeon. Particularly important are the abilities to operate in a three-dimensional environment while observing a two-dimensional image and to operate using very long tools, without the normal tactile feedback received when performing open surgery.

Other pressures have also increased the need for the development of better methods of training and assessing surgeons. Shorter training as a result of the Calman Report has resulted in the development of courses to train core skills for both basic and higher surgical trainees. Political pressure in the aftermath of the Bristol Children's Hospital Inquiry (!) has heightened the need for reliable and valid ways of training surgeons, both in and out of the operating theatre.

Assessment is a key part of training, but finding valid and objective methods of assessing surgical performance has proved difficult. The assessment of surgical performance and skill has become a major focus of research within our department at Imperial College and at several other medical schools.

Assessing laparoscopic dexterity

The surgical accreditation process includes extensive examination of many areas of knowledge, but practical aspects, particularly dexterity, remain unassessed in most surgeons. At Imperial College we have developed a computer based system to assist with the assessment of surgical dexterity.

Dexterity is only one of many skills that a surgeon needs to perform safe and competent operations. Surgery is said to be 75% decision making and 25% dexterity.

Initially, our work looked at motion analysis as a measure of dexterity, while performing a computer based simulation of laparoscopic surgery. Mechanical tracking devices collect data on the position of the simulated tools as a task is performed and the data are analysed by a custom built software package. This combination of hardware and software, which has been named the Imperial College Surgical Assessment Device produces data from which speed and accuracy of movement can be derived.

Adapted mechanical tracking devices, allow the movements of surgeons to be analysed as they perform simple physical simulations of real laparoscopic surgery, such as pulling and cutting pieces of thread. The measures produced appear to be valid reflections of laparoscopic skill and show differences between experienced and less experienced surgeons. New developments allow tracking systems to be used on surgeons performing real surgical procedures in the operating theatre so that direct comparison can be made between simulated and real operations.

Effects of alcohol

Alcohol misuse in the medical profession is well documented. Some reports suggest that as many as 42% of health workers have reported for work with a hangover. While commonsense suggests that performance might be impaired if the surgeon is either intoxicated or hungover, there are few data on how surgical performance is affected by alcohol. Pilots have a 'bottle to throttle' time, but there are no such rules for surgeons. The advent of training and assessment tools such as the Imperial College Surgical Assessment Device provides an objective method of measuring the decrement in skill following alcohol ingestion. Such tools might provide evidence on which to base policies for safe drinking practice, including limits on amount and the time between alcohol ingestion and surgery.

Our study has looked at the effect of alcohol on simulated laparoscopic task performance in a group of trainee surgeons and students, all of whom were familiar with laparoscopic techniques. In order to minimize training and cognitive effects all 12 subjects trained extensively on the

simulations before the study. Subjects were randomized into a two by two crossover trial. On different occasions each subject would be given either a full alcohol dose in orange juice (alcohol 0.8g/kg) or a placebo orange juice on to which a very small amount of alcohol had been layered (alcohol 0.1g/kg). The full dose was intended to produce a blood alcohol level similar to that of the legal limit for driving. The crossover design allowed within subjects analysis and controlled for learning. On each occasion, subjects were tested before drinking, and then for 8 hours after ingestion. The subjects were tested on a virtual reality simulator, and while performing tasks within a standard closed box laparoscopic training device. Performance of each task at each test occasion was monitored using the Imperial College Surgical Assessment Device. The blood alcohol level at each test time was assessed using a breath alcohol device, which was recalibrated on each trial day.

Results show trends across many measures of dexterity in the acute phase of alcohol intoxication. In the full dose group, the only significant impairment of virtual task performance was prolonged time to undertake a simulated diathermy task (making a precise burn on a target at a distance) 1 hour after ingestion when the mean blood alcohol concentration was 77.9 +/- 8.1 mg/dl. Impaired learning with reduced efficiency of movement also occurred and lasted for up to 6 hours after ingestion.

Assessment of performance on real surgical tasks shows more dramatic effects, particularly on the learning curve. Although all subjects had been extensively pre-trained on the systems, the placebo group showed improving efficiency of movement with repeated

performance of the tests over 8 hours on the same day; the full dose alcohol group did not show this learning effect.

Although there was some recovery from the initial detriment in performance, significant differences in several aspects persisted 6 hours or more after reaching a peak level of less than 80 mg/dl. This effect is seen particularly in performance scores for left handed tasks (all subjects were right handed), in terms of both distance travelled and number of movements made to complete the task.

The results are especially important for surgeons in training because impaired learning is still seen 6 hours after ingestion of alcohol. If a detriment in learning can be demonstrated so long after reaching a level similar to the legal driving limit, then more excessive drinking might impair performance and, in particular, learning for a longer period.

While no one condones being intoxicated with alcohol when on duty, few people consider it necessary to avoid alcohol the night before operating. Further studies might be specifically aimed at the effect of hangover, with the aim of defining safe 'bottle to theatre' times for surgeons.

Sleep deprivation

The cognitive and psychomotor impairments incurred by sleep deprivation have been well documented outside the medical field, and some studies have also been made of doctors working in medical specialties. However, although surgeons often experience sleep deprivation or disturbed sleep, no studies have been made of the effects of abnormal sleep patterns on surgical performance.

Six surgeons were entered into a six by six crossover trial, designed in a Latin square. Each subject spent two nights in each of three sleep conditions:

- A full night's sleep
- A night where subjects were allowed to sleep, but were woken every three hours, kept awake for 15 minutes, then allowed to return to sleep.
- A night where subjects were kept up and awake all night.

Their performance was tested using the virtual reality simulator on the evening before, and the morning after the study night. The subjects made significantly more errors in performing tasks and took more time after sleep deprivation. A sleep-deprived subjects also showed increases in stress and decreases in arousal (as measured with questionnaires).

This study has shown impaired performance produced by both disturbed and absent sleep as assessed on surgical simulators. The relevance of this to clinical outcome is unclear until it is decided how closely such laboratory based trials using a simulator parallel real clinical practice. However, surgical policy on working hours and sleep patterns might well be influenced by such studies.

Conclusion

Simulators and objective tools for the assessment of surgical skill have been developed and could be used in the training and accreditation of surgeons. Their role in assessing performance under differing environmental conditions has yet to be fully exploited.

The optimal conditions under which a surgeon should work are far from clear.

Our studies suggest that surgical performance can be impaired both by alcohol and by sleep deprivation. Appropriate policies on hours of sleep and consumption of alcohol might result in improved performance by the surgeon and improvements in surgery for the patient.

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