MEDICAL PRACTICE

Hospital Topics

Ambulance ride: fixed or floating stretcher?

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The alternatives of a purpose-built ambulance and a specially designed stretcher suspension system were considered and the features of the latter assessed by subjective and objective tests. The results showed a significant improvement in the quality of the ride offered to the patient.

Introduction

In earlier papers on medical aspects of ambulance design^{1,2} various design factors affecting patient care were investigated and discussed. The vibration of ambulance ride was shown to be of clinical significance to the comfort and condition of certain patients¹⁻⁴ and calls into question some of the factors that influence present ambulance design: (a) the dual-purpose role with wide range of weights carried, affecting suspension design; (b) the economics of commercial van conversion over a purpose-built vehicle; (c) the lack of ambulance design standards relating to noise, heating, lighting, and vibration; and (d) the lack of ergonomic standards relating to performing life-support tasks within the vehicle.

Recent research has shown methods of investigation and improvement^{1,2,5-8} in conventional ambulance design. The ride

on the stretcher may be improved by computer-aided chassis design^{1,2} or isolating the stretcher on a special suspension system. This latter method has been developed at Delft University⁹ in Holland and is known as the floating-stretcher support. The first unit to come to Britain was loaned to the City of Bath Ambulance Service for subjective assessment and computer analysis of the ride characteristics.

The floating stretcher

The floating stretcher suspension system (fig 1) operates as follows. Two push-button-controlled electric motors tension compression springs, which in turn act through a damped cantilever system that floats the patient and stretcher up into the mid-range of the springs, compensating for the patient's weight. When the ambulance is moving the vertical vibration transmitted from the road surface by the wheels and suspension system is reduced. Particular attention has been given to reducing the frequencies known to excite motion sickness (around 0.3 Hz) and body resonances (4-10 Hz). The floating stretcher is also designed to reduce the effect of roll on corners and may be used to keep the patient horizontal or give a head-down tilt. In use, the trolley

FIG 1—Diagram of working principle of floating stretcher.

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stretcher is placed on the retractable loading tray with the floating stretcher in the fixed or down position. The electric motors are then actuated, and within 15 seconds the stretcher is raised to the floating position and the ambulance may be driven off.

Subjective assessment

METHOD

The floating stretcher was fitted to a standard ambulance as used in a previous computer analysis of ambulance ride.¹ A random series allocation was then made for 100 patients to be given either the first or second half of the journey to hospital in the fixed position (the ride being the same as in the standard ambulance) and the other half in the floating position. At the end of the journey the patient was asked which half of the journey was the more comfortable and to grade the comfort on a numerical scale: 1, very good; 2, good; 3, average; 4, fair; and 5, poor. The ambulancemen were instructed to avoid introducing bias, and when changing from the fixed or floating position the patient was simply informed that his position was being "altered."

RESULTS

A total of 100 patients (40 male, 60 female, aged 4-95 years) with the usual spectrum of medical, surgical, and traumatic complaints were carried for an average of $6\frac{1}{2}$ miles (10.5 km), the range being $1\frac{1}{2}$ to 100 miles (2.4 to 160 km). One patient weighed 115 kg. Ninety-two patients preferred the floating position, one the fixed position, and seven were unable to say. Only four patients admitted to any feeling of nausea, and then only after being specifically asked. These results are significantly ($P < 0.0001$) in favour of the floating position.

Of 91 patients who could grade the ride, 47 thought it very good, 33 good, 7 average, and 4 fair. Six patients asked to be allowed to revert to the floating position after experiencing the fixed position. The smoothness of the ride evoked unsolicited comment from 56 patients, ranging from "very comfortable" to "the best journey ever experienced in hospital transport" from a veteran ambulance traveller.

The range of medical complaints of the patients varied from acute urinary retention needing no treatment on the journey to severe head injury requiring constant aspiration of the airway. In no case was the attendant's ability to treat the patient influenced adversely by the floating action of the stretcher. This was aided by loading the patients into the ambulance feet first and by positioning the attendant at the head of the stretcher, where he could both attend to the patient and see where he was going.

RS accompanied 10 of the patients in the ambulance, and on the return journey lay on the stretcher and made subjective assessments over varying distances and conditions. At no time was nausea experienced; the floating position was always found to be the more comfortable, and with a purposefully overfull bladder on a bumpy road the floating position dramatically eased the definite discomfort of the fixed position, indicating the response to vehicle ride with a distended viscus.

Computer analysis

METHOD

Readings were taken in the ambulance with an accelerometer placed on the frame of the stretcher (fig 2) to measure vibration in the vertical axis using the same conditions of speed, road surface, and vehicle loading as in the previous vibration analysis.¹ The results were recorded on an SE Laboratories Eight-Four instrumentation recorder and analysed by computer at the Institute of Sound and Vibration Research.

RESULTS

The results showed a significant reduction in both the overall (root mean square; rms) and peak values with the stretcher in the floating position (fig 3). When compared with the results obtained in the purpose-built research ambulance and a private car the floating stretcher was seen to improve on the research ambulance results to the point of being almost equal to those obtained in the car.

FIG 2—Ambulance fitted with floating stretcher, showing patient with accelerometer attached to stretcher, FM data tape recorder, and oscilloscope. Stretcher is in floating position. (Reproduced by permission of Accident and Ambulance Research, Bath.)

FIG 3—Vertical acceleration measured on floating stretcher in fixed (or standard ambulance) and floating positions compared with that in research ambulance and private car, showing peak acceleration at natural frequency and g/rms values for 0-60 Hz.

The results were then analysed and plotted as graphs to show vertical acceleration against frequency of vibration (fig 4). The graphs show the results obtained with the floating stretcher in the fixed and floating positions compared with those obtained under the same conditions in the purpose-built ambulance and the car. The results show a reduction in vertical vibration when the floating position was compared with the research ambulance in the all-important 3-10 Hz range. Only in the 10-25 Hz range was the advantage reversed.

Detailed examination of a further 18 computer print-outs showed that when the fixed or standard ambulance position was compared with the floating position a 42% reduction in volts rms/g was obtained. An even higher ratio was obtained between the peak-to-peak values—that is, a 50% reduction—and when the power spectral density results were compared at the frequencies of resonance the ratio between the fixed and floating modes increased to 3:1, or a 66% reduction in the floating position. To give a visual indication of the different energy levels obtained in the fixed and floating positions a short section of direct signal trace obtained from the accelerometer is shown in fig 5.

FIG 4—Vertical acceleration on floating stretcher in fixed (or standard ambulance) and floating position compared with that in research ambulance and private car as a power spectral density plot of g^2/Hz against frequency.

Discussion

The need for improving ambulance transport has been clearly stated.¹⁻⁴ The choice seems to lie between the purpose-built ambulance and a special stretcher suspension system on a standard commercial van chassis. The development of the latter has been taken to the point of commercial availability and offers advantages over the standard ambulance conversion as used in Britain and much of Europe. The cost of the floating stretcher is about the extra cost of a purpose-built ambulance (25% increase). Initial application could be found in the field of special-risk cases such as spinal injuries or critical cases.

Finally, it must be emphasised that the floating stretcher is commercially available now and the purpose-built ambulance is not. That this is so is perhaps a sad commentary on the priority afforded to the work of the ambulance service in Britain.

We acknowledge the help of FM Equipment Ltd, Bradford, Yorks; Dr S Blok and Mr A Van Zandvoort, of Laura Vico (Vibration Control Dept) Research and Development, Eygelshoven, Netherlands, for the loan of the floating stretcher; and the City of Bath Ambulance Service for allowing the equipment to be tried in a standard ambulance. We also thank Mr M Perry, of SE Laboratories, for the loan of the SE

FIG 5—Direct trace from accelerometer output giving visual indication of difference between floating and fixed (or standard ambulance) positions (1.5-s section of identical road conditions).

Eight-Four FM data recorder; the Institute of Sound and Vibration Research at Southampton University for the facility for data analysis; Mr John Oliver, of the Motor Industry Research Association at Nuneaton, for valuable guidance; Mrs G Machin, of the department of medical photography, Royal United Hospital, Bath, for preparing the illustrations; Mrs A J Collins for statistical advice; and Mrs R Snook for secretarial help.

Requests for reprints should be sent to RS.

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Can short-wave diathermy and heat treatment given to a lesion that subsequently proves to be malignant accelerate the spread of the growth?

According to physiotherapy textbooks the answer is "yes," although the statement is invariably unsupported by references. Scott¹ says that short-wave diathermy increases mitosis, while Kovacs² says that the basal metabolic rate is increased and tends to remain at a higher rate after treatment. Recent books merely state that such treatment should not be given, advice presumably based on these older texts.

¹ Scott, B O, *Principles and Practice of Electrotherapy and Actinotherapy*. London, Heinemann, 1957.

² Kovacs, R, *Electrotherapy and Light Therapy*, 4th edn. London, Henry Kimpton, 1942.

Tropical fish are a Japanese food delicacy but certain parts of their bodies are highly poisonous. Is there any treatment if an inadequately prepared fish is eaten?

Tropical fish contain a wide variety of poisons, and, indeed, a species of fish that has lived on one part of a coral reef may be poisonous and those of the same species from another part of the reef safe to eat.

There are also many different species of tropical fish, and only some of the toxins which they contain have been identified. The principal toxins from Pacific fish are, however, anticholinesterases, and it would therefore be worth while to treat an affected person for anticholinesterase poisoning. For this the patient should be given 2 mg atropine intramuscularly or intravenously, the dose being repeated every 10 or 13 minutes until signs of "atropinisation" appear—namely mydriasis, tachycardia, and dryness of the mouth. Up to 20 mg of atropine may be required to produce these effects. Pralidoxime is a specific cholinesterase reactivator and may be given intravenously, intramuscularly, or by mouth in doses of 1-2 mg and repeated if needed. Artificial respiration may be required, and maintenance of a proper airway is essential.

Is carbon dioxide treatment successful in treating brain damage?

There is no evidence that brain damage is helped by carbon dioxide therapy. I certainly use small amounts of carbon dioxide to increase the circulation of blood to the brain, but it is not sustained nor is brain performance or function improved.