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Clinical decision making with the aid of ambulatory monitoring of heart rate

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Abstract

Routine assessment of heavily handicapped patients by means of speed and heart rate has been carried out in ORLAU over the past four years. The methodology and the apparatus have been described by Davies (1977) and Stallard et al (1978), who also indicated its value in terms of research. Gradually the technique has been assimilated as a routine clinical assessment procedure, and a number of cases in which it has positively influenced treatment are described in order to illustrate its benefits.

The simplicity of the methodology and portable nature of the equipment enable physiotherapists to carry out many assessments in schools, greatly minimising disruption for the patient and maximising the effectiveness of the procedure.

Analysis of the types of assessment which had been conducted showed that they could be divided into six categories:

Learning time for a new orthosis
Relative value of a new orthosis
The need for operative procedures
The value of operative procedures
Indication of areas requiring further investigation
Confirmation of clinical opinion

When used in conjunction with the other assessment techniques available in ORLAU, monitoring speed and heart rate become a powerful tool for routine clinical evaluation of patients.

Introduction

The Orthotic Research and Locomotor Assessment Unit have been carrying out assessments of heavily handicapped children for the last four years. For three and a half of those years clinical comparisons of physical effort pre and post treatment have been made on the basis of heart rate and speed of ambulation.

Justification for embarking on a research programme to evolve clinical assessment procedures came from the work of various physiologists who had shown that heart rate was related to oxygen uptake, and this work is exemplified by Astrand and Rhodahl (1970). In order to further confirm the validity of the approach an M.Sc. study of the technique applied to heavily handicapped subjects was commissioned from the Department of Physiology at Birmingham University. The results of this scientific study, Hill (1978), showed that heart rate response could, with certain limitations, be used as an indicator of performance in handicapped subjects using walking aids. The methodology of the technique has been described in papers by Davies (1977) and Stallard et al (1978) and in one presented at the ISPO World Congress in New York (Stallard et al. 1977).

The virtue of the technique in assessing the merit of a particular apparatus has been demonstrated in the development of the Salop Skate (Davies & Lucas, 1977, and Stallard & Rose, 1978) and also in research into various types of crutch (Stallard et al, 1978). Whilst all these publications have indicated that the method is valid, and useful in particular areas of research, they have not adequately shown its value in routine clinical assessment of patients. The routine clinical assessments of patients using heart rate monitoring to compare relative effort carried out in the last three and a half years, both at the Unit, and in various schools attended by severely handicapped patients, have been very successful and have had a positive effect on the treatment of many patients.

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Clinical assessments

Two standard test procedures have been devised for assessment of handicapped patients. The heavily handicapped are asked to walk 5 runs of 20 ft and are given one minute standing rest between each run. Heart rate is monitored throughout the trial and the rate at the end of each timed run noted. This enables the speed and heart rate of the series to be plotted against run numbers. Comparison of different trials gives a clear visual and quantitative indication of the change in both speed and heart rate, so that the effect of treatment is immediately apparent.

Less handicapped patients are asked to walk 80 ft runs continuously until they are tired or uncomfortable. The speed and heart rate are plotted against run number, and comparisons of different trials give an indication of the changes in speed, heart rate and endurance which have occurred.

Assessment in schools is made possible by the portable nature of the apparatus (Fig. 1).

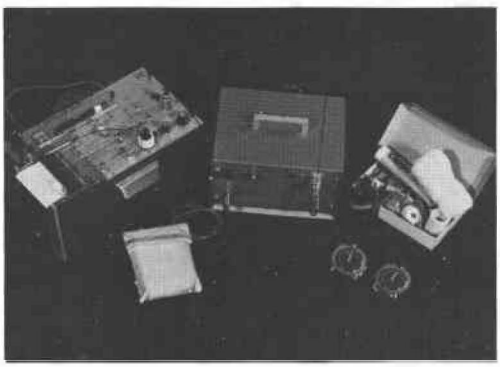

Fig. 1. Portable heart rate telemetry equipment.

Physiotherapists can visit the schools, taking with them a small transmitter, receiver and pen recorder, and this has the twin advantage of minimising emotional disturbance and loss of academic activity. This is particularly important when a series of trials is necessary to establish that a patient has completed his "learning curve" and established a steady performance. An example of this was a patient (G.L.) for whom a hip guidance orthosis (hgo) (Farmer et al, 1976, and Rose, G. K. 1979) had been prescribed as an interim learning device, after which it was considered that he would graduate to KAFO's only. The change to KAFO's was monitored carefully over a series of weekly assessments (Fig. 2), starting with an initial assessment in hgo. When the patient's performance had reached a plateau, it could clearly be seen that he not only walked slower by 20% but that this slower speed was costing 10 bpm more heart rate. On this basis a clinical decision was taken to return him to hgo.

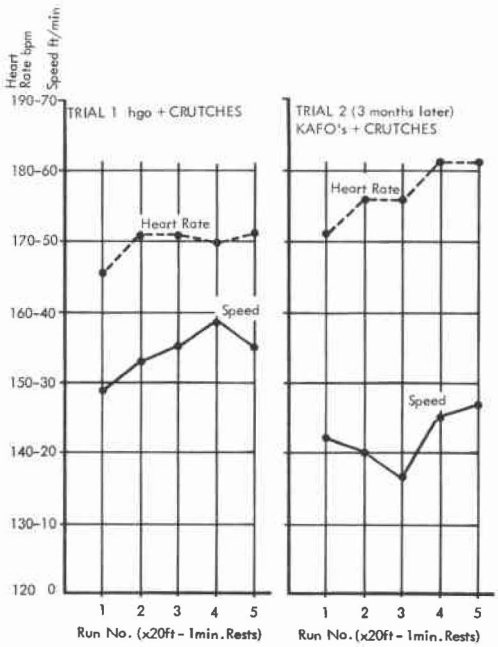

Fig. 2. Change from hgo to KAFO, (patient G.L.).

Most patients using hgo start by using a rollator as a walking aid. This is a cumbersome apparatus, but it does give patients a feeling of security. Whenever possible, patients are encouraged to use crutches and in cases where there is doubt as to their ability to cope, the learning process is regularly monitored in the school environment. A typical result of such an assessment is shown in Fig. 3. Initially an assessment with the patient using a rollator was taken. For comparison with this the "plateau" result at the end of the series is shown. From this it can be seen that speed had dropped, but that this was accompanied by a drop in heart rate. Although this was not a clear cut result in favour of one or the other, it did give sufficient

indication that crutches were not significantly less efficient so that the convenience of crutches was worthwhile.

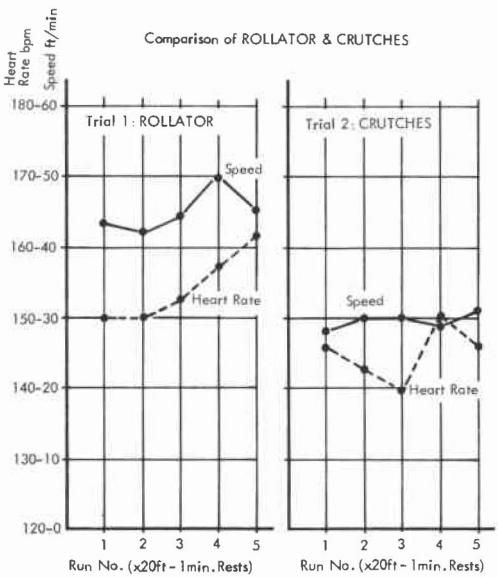

Fig. 3. Change from rollator to crutches (patient K.E.P.)

A replacement apparatus is monitored in schools whenever facilities for this are available, and the data is entered in patients' notes. This has benefits which cannot always be foreseen. A patient with excessive lordosis who used hgo was provided with a replacement hgo which ostensibly had the same specification. An eagle-eyed physiotherapist spotted from her own routine assessment (encouraged by ORLAU Education Programmes) that the number of steps the patient was taking for 20 ft had increased, even though the times were virtually identical. Examination of the records showed that this was not detrimental since the patient's heart rate was also virtually identical. It transpired that a slightly smaller flexion angle on the hip range stop had been provided on the new device. The patient preferred the more upright posture provided by this flexion angle, and since it was seen not to be detrimental it was left as it was. Without proper assessment technique, the temptation would have been to adjust the apparatus to the original setting.

Although many routine assessments do take place in schools, it is also frequently necessary to carry out more searching investigations in the ORLAU gait laboratory at Oswestry, where a greater range of facilities and tests are available. Since this is situated within the hospital complex, pre-operative investigations are undertaken as are problems encountered within routine clinics. The improved facilities for function testing of patients include automatic timing, digital read-out of heart rate and video recording in three orthogonal planes. In addition there is instrumentation available to monitor ground reaction forces, ambulatory EMG, foot-ground contact, under-sole pressure development and step pattern and timings. This range of instrumentation has enabled many clinical decisions affecting patient treatment, both operative and orthotic, to be taken on a much sounder basis. Heart rate monitoring is playing an increasingly important role in this sphere of activities.

Results from such assessments often have the effect of convincing not only the clinician, but also the patient and their guardians of the wisdom of a particular treatment. Just one example of this was a patient with spastic diplegia giving bilateral ankle instability. The girl (T.W.) had a low level of handicap and could walk with no orthoses or other apparatus. Her main problem appeared to be an inability to stand still. The patient was assessed using video recording of her gait pattern and monitoring of speed and heart rate over continuous 80 ft runs until she wished to stop because she was tired. Bilateral plastic below-knee fixed ankle orthoses (AFO's) were prescribed and a re-assessment carried out after she had used these for 6 months. From the visual record by video, no significant change in the gait pattern could be observed, other than an improvement in the patients ability to stand still. On that basis alone, there would have been a temptation for the patient to discard the apparatus. However, the assessment of ambulation by means of speed and heart rate (Fig. 4) showed that the orthoses gave a very considerable advantage in terms of function. Not only did the speed rise by 30 ft/min (15%) for a concurrent drop in heart rate of 20 bpm, but the patient walked more than twice as far before she gave up because she was tired. With this information available, there was no question of the orthoses being discarded.

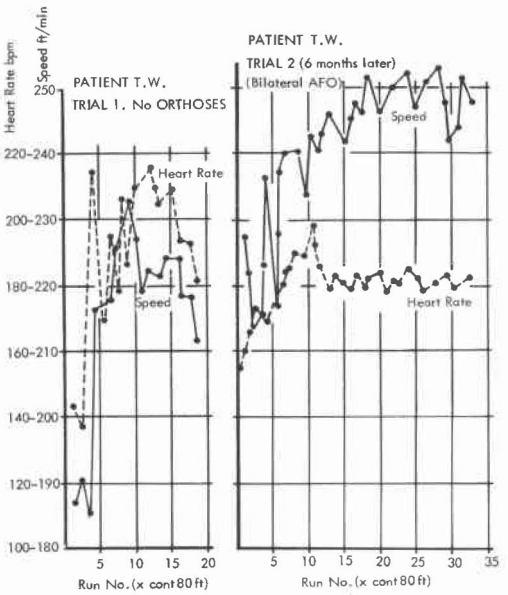

Fig. 4. Adoption of AFO's (patient T.W.).

The results of assessments sometimes lead, in addition to influencing clinical decisions, to more searching investigations of a fundamental problem. Patients with progressive deterioration of motor power in the lower limbs, coupled with flexion deformities in knees and hips, present problems of treatment philosophy with regard to the orthotic treatment which should be used, and the timing of surgical intervention. One such patient (DB) refused surgery for straightening of the knees and hips, despite the increasing difficulty in maintaining her ambulatory status. She had been using plastic fixed ankle AFO's and the treatment adopted after refusal of surgery was bilateral long leg calipers (KAFO's) to stabilise the knees. These do have disadvantages in terms of increasing vertical movement of C of G, which ostensibly should lead to greater energy expenditure. In the case of this particular patient, greater instability also required the use of a walking stick. The advantage of KAFO's was clearly demonstrated by an assessment using 5×20 ft runs with one minute rests (Fig. 5). Using AFO's the patients heart rate rose gradually throughout the trial to 152 bpm, with greater increases often occurring during the standing rest periods. However, when using KAFO's the heart rate was contained at a steady level of 128 bpm for each 20 ft run and returned to approximately 110 bpm for each rest period. AFO's were clearly costing the patient an ever increasing effort merely to stand still, as indicated by the high heart rates during the standing rest period. Apart from confirming the wisdom of KAFO's for this patient, the assessment led to more fundamental research into the problems of such patients. A programme was undertaken to establish EMG activity in the lower limbs of such patients compared to normal and also a comparison of their C of G movements.

One of the most important functions of these assessment procedures is to monitor the effect of surgical treatment. It is particularly useful with C.P. patients, and the two following cases are typical examples of many such assessments.

A patient with good function, but with a bilateral internally rotated equinus deformity (L.M.) was anxious for a cosmetic improvement due to the considerable number of taunts suffered at the hands of his peers. Bilateral derotation osteosomy with elongation of the tendo Achilles was carried out. The effect of this was to markedly diminish the patients speed coupled with a lower heart rate when monitored on continuous 80 ft runs. There was no significant

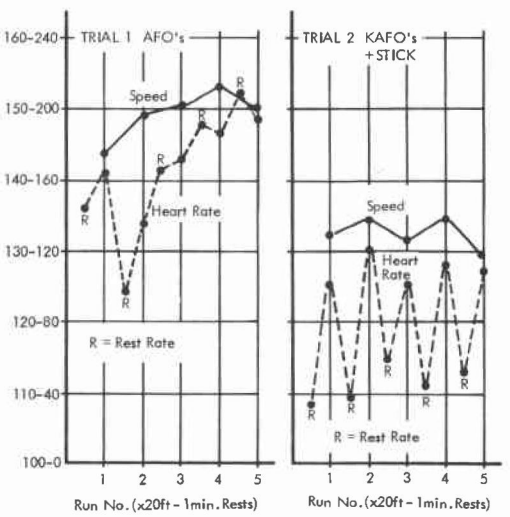

Fig. 5. Comparison of AFO's to KAFO's (patient D.B.).

change in endurance, the patient managing a high number with no significant difference pre and post operatively. The improvement in the appearance of his gait was greatly appreciated by the patient, and in his view this more than outweighed the disadvantage of the lower speed, particularly in view of the reduced heart rate which indicated that efficiency had not been markedly affected.

A patient (D.J.) was referred to the unit for assessment prior to bilateral elongation of the tendo Achilles. This showed that he had very good ambulation function (high speeds for low heart rates) suggesting that little more than a cosmetic improvement could be expected. The treatment was undertaken on that basis and post operative assessment showed that function had not been impaired in any way, with speeds and heart rates for the continuous 80 ft runs assessment being virtually identical some 6 months after the completion of operative procedures. Visual recording by video did show that a significant change in gait had been achieved, the equinus deformities which had previously given a bilateral toe strike being transformed to the extent that heel strike was achieved on one side with a foot flat strike on the opposite side.

A further advantage of heart rate monitoring which has shown up during the assessment of heavily handicapped patients using a new device has been the indication of a lack of effort from the patient. This has been valuable in determining the course of treatment. An example of this occurred with an adolescent patient (L.H.) for whom the Salop Skate, (Davies & Lucas, 1977, and Stallard & Rose, 1978) a device which eases 'drag-to' gait, was prescribed. Initially trials had indicated that speed was increased by 50% with a reduction in heart rate of 10–15 bpm. At a 3 month follow-up assessment during a holiday from the patient's residential school, the device had ostensibly become much less effective. Speeds compared to 'drag-to' gait were lower with an apparently greater effort for the patient. However, when heart rate results were analysed (at that time they had to be calculated from ECG recordings) it could be seen that they were comparatively low. Further questioning of the patient showed that an antipathy to the device had developed, due probably to its strange appearance arousing comment from peers at school. Without the information from the heart rate results this would probably not have been discovered, because the patient was clearly worried about the reaction her antipathy was likely to arouse in the therapists. Naturally, the device was immediately discarded without further trials which would have caused unnecessary distress to the patient.

Confirmation of an impression gained from clinical examination is a further valuable asset of function assessment using heart rate. A spina bifida patient with diminished motor power in the lower limbs (I.P.) was routinely examined, when it was considered that deterioration had occurred during the 12 months since her previous full examination and functional assessment. Because a routine assessment had been carried out, this opinion could be tested. When this was done the clinical opinion was confirmed (Fig. 6). Speed had dropped by approximately 70% for the same heart rate, and only three quarters of the original distance was covered.

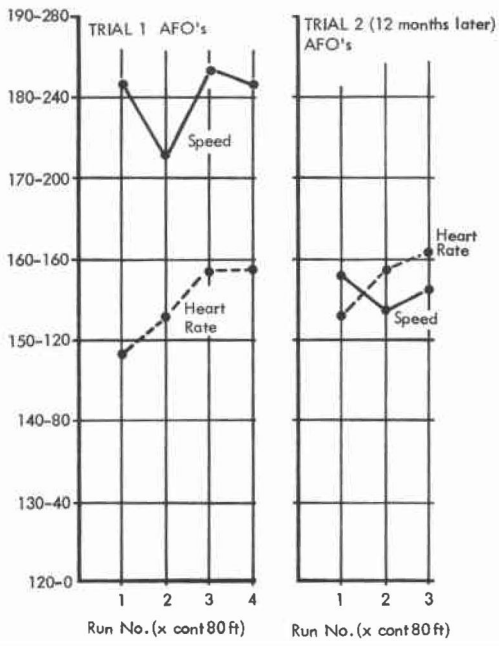

Fig. 6. (I.P.) Confirmation of clinical opinion (patient I.P.)

Conclusion

The experience gained by ORLAU in routinely assessing ambulation function of handicapped patients using radio telemetered heart rate to gauge relative effort, has strengthened the view that this is a valuable procedure. From the cases quoted, who form a small proportion of the number of positive contributions from such procedures, it can be seen that the various ways in which it is of value can be categorised:

Assessing the learning time for a new orthosis
Assessing the value of a new orthosis
Assessing the need for operative procedures
Assessing the value of operative procedures
Indicating areas requiring further investigation
Confirmation of clinical opinion

With a comparatively small amount of apparatus physiotherapists can carry out routine assessments of children in schools. The amount of time taken up by such procedures is of the order of half an hour and they can therefore be repeated at frequent intervals with minimal interference to the child's schooling. This has proven particularly valuable when new orthotic devices have been prescribed to which the adjustment of the patient needs to be carefully monitored.

Continuous digital readout of rate in the gait laboratory is a great asset. It permits interpretation of various activities without the need to specify the activity prior to the event. This has led to a better understanding of some patients problems and enabled more effective treatment to be prescribed.

Although post-operative assessment cannot alter the result of a procedure, it does give confidence that treatment for patients is proceeding along the correct path.

The experience gained in moving out of the research programme into routine clinical assessment indicates that the simple procedures adopted could be used to great advantage in physiotherapy departments coping with severely handicapped patients. Not only does it improve the assessment of patients, but it also gives a greater insight of the prescribed treatment to the therapists involved.

Centres where searching investigations of more difficult cases can be undertaken are fully justified by the experience of ORLAU. In such centres heart rate assessment of relative effort would be but one of a whole range of techniques, but nevertheless fundamental to the operation of such a centre.

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