A NEW APPROACH TO HANDLING IN INDUSTRY

A RATIONAL APPROACH TO THE PREVENTION OF LOW-BACK PAIN

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In the Somerset West Factory of African Explosives and Chemical Industries there is a high incidence of low-back pain among European employees, who are chiefly supervisors, whereas among the Africans, who do the manual work at the factory, the incidence is low and the time lost of little significance. In the past 6 years reasonably accurate records have been kept of the employees who have been absent from work because of painful backs. The results (Table I) are quite illuminating. In view of the great

TABLE I. TIME LOST OWING TO LOW BACK PAIN, 1956–61

Year	*Europeans*		*Africans*		*Coloured*	
	Occasions	*Days off work*	*Occasions*	*Days off work*	*Occasions*	*Days off work*
1956 ..	70	1,266	26	133	12	61
1957 ..	69	1,247	16	45	10	39
1958 ..	70	561	21	67	10	52
1959 ..	56	502	16	56	8	32
1960 ..	42	926	20	93	7	69
1961 ..	34	558	21	132	14	69
Total ..	341	5,060	120	526	61	322

number of man-hours lost from this cause it is not surprising that, having received information from the Nobel Division of Imperial Chemical Industries of the work done at their factory at Ardeer, Scotland, in the field of Kinetic Handling, both the Safety and Medical Departments at the factory should have been interested.

Kinetic Handling is based on the work of Anderson,[1] who spent 25 years investigating body movements in sport and industry. The aim of Anderson's work in the industrial sphere has been to teach workers how to avoid the accidents and disabilities associated with industrial strain and fatigue. Human kinetics, on which this work is based, is defined as the study of the mechanical, reflex and mental factors which influence muscular actions as a means of producing maximum standards of physical efficiency with the minimum of cumulative strain.

What is cumulative strain? Anderson defines it as the increasing stiffening of body tissues resulting from sustained and consistent contraction of muscles. An exaggerated example of this is seen in Fig. 1, which shows a stoker who played bowls in his spare time, thus aggravating a stance which was already typical of his trade. Muscles subjected to constant repetitive action, when that action involves the use of excessive force and inadequate relaxation, are liable to develop cumulative strain. It is suggested that, when muscles contract near to their maximum force over prolonged periods, the effect is to interfere with their circulation and therefore with their nutrition and the evacuation of metabolites. This tends to produce excessive fatigue and eventually an increase

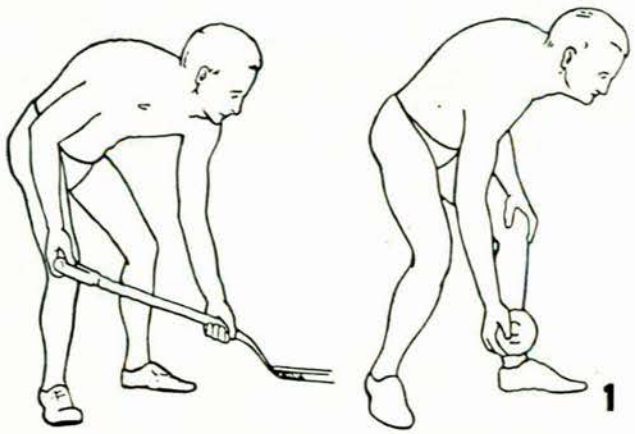

Fig. 1. Postural characteristics at work and at play. *Reproduced by permission of T. McClurg Anderson and William Heinemann.*

in fibrous tissue or permanent shortening of the muscles that contract, and over-stretching of the muscles that relax. This interferes with the efficiency of the muscles and their ability to react quickly in time of stress and finally leads to cumulative strain. Brute-force methods are therefore condemned and in their place is substituted the scientific use of a larger number of muscles, contracting and relaxing rhythmically and so resulting in less fatigue.

The question may be asked whether this is not contrary to the methods widely used in athletic training today, in which weight-lifting plays such an important part. I do not think so. De Lorme,[2] who advocates 'progressive resistance exercises', which are based on weight-lifting principles, for building up muscles after illness, injury or operation, recommends only 30 lifts per day, arranged in 3 progressions of 10 each for 4 days a week, though he stipulates that these lifts must be made at maximum output.

Tucker[3] states that with occupational and postural strains muscles become fatigued and strained and show areas of spasm which are tender; the muscles lose their resilience, become inefficient and no longer adequately support the underlying joints. Electromyographic studies show the presence of spasm in these muscles. Two explanations of this spasm are advanced, viz. (1) nerve-root irritation from adjoining strained joints, and (2) fatigue of the muscles, leading to the accumulation of metabolites. Tucker's impression is that in the early stages of postural strain something accumulates in the tissues, resulting in pain and tenderness. At this stage there are no structural changes and the condition is reversible. It seems logical that persistence in wrong posture, which is associated with excessive stretching and shortening of muscles, must eventually lead to cumulative strain with, in very gross cases, the defective posture typical of a trade.

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Further, Anderson postulates that the natural way of performing a task is not of necessity the best way. It is probably a natural way as a result of imitating others; e.g. when picking up a box you are probably imitating your father, who in turn was possibly imitating his father. There is, however, no guarantee that the working methods which suited your grandfather are the right ones for you. Here the remarkable freedom of the African from low back strain comes to mind.

Carrying this argument a stage further it is clear that, when lifting and carrying objects, the average worker tends to think only of the immediate problem of lifting the object off the ground and not sufficiently of the movements that often follow on the lift. If Kinetic Handling achieves nothing else, it certainly teaches the worker to study the lift as a whole. His initial position may appear rather uncomfortable, but his subsequent movements are rhythmical, relaxed and perfectly coordinated. The 6 key factors of Kinetic Handling are the following: (1) straight back, (2) chin tucked in, (3) elbows into the side, (4) palmar grip, (5) proper foot positions, (6) use of body weight.

1. *The Straight Back*

There is no need to elaborate on the straight back. In this age of discs and sputniks it is generally agreed by orthopaedic surgeons and physical-medicine specialists that lifting should be done with at least a straight back, but preferably also with an erect back.

Floyd and Silver[4] state that with the spine in the erect or neutral position, and also in extreme flexion, the erector spinae muscles show minimal activity, but that as soon as movement begins they contract strongly. These findings indicate that in the upright or neutral position the body weight is transmitted through the bony vertebrae and the intervertebral discs, i.e. the spine is stabilized and all the muscles are relaxed. This is supported by Jonck,[5] who investigated Africans carrying heavy bags on their heads. He was impressed with the fact that the stresses and strains were far less than in any other way of carrying bags. This is understandable, for in the erect position the diarthrodial joints are locked, so that their supporting structures, as well as the weak posterior common ligament with which the relatively loose fibres of the posterior portion of the annulus fibrosus blend, are not subject to the same degree of tension as when the back is arched. Therefore, pain due to relaxation of ligaments, as enunciated by Hackett,[6] or due to minor degrees of derangement of the intervertebral and diarthrodial joints resulting from degenerative changes in the intervertebral discs, is less likely to occur. Moreover, the erector spinae muscles have a double action, both initiating movement and resisting the forces of gravity in order to maintain the stability of the vertebral column. With an erect back, then, these muscles are likely to tire far less since they are no longer performing this double action.

Further, tone in the erector spinae tends to compress the lumbar discs and therefore increases their pressure; this is well shown on lifting a weight. Bradford and Spurling[7] have pointed out that if the nucleus pulposus is the fulcrum when the back bends on lifting a weight, the contraction of the erector spinae balances the weight lifted. The back and arms form a long anterior lever and this is balanced by a short posterior lever, the ratio being in the nature of 15 : 1. This means that when a weight of 100 lb. is lifted, the balancing force must be almost 1,500 lb. and the disc is compressed to a value of 1,600 lb. Some doubt has been cast on these figures by Bartelink,[8] who has found experimentally in a small series of post-mortem specimens that the breaking strain of a disc ranges from 350 lb. to 1,400 lb. with an average of 750 lb. He suggests that the controlled rise of intra-abdominal pressure as a result of contraction of the transverse abdominal muscles results in a balloon-like effect which serves to bolster up the spine and relieves the disc of about 300 lb. of pressure.

However, Davis,[9] comparing the rise of intra-abdominal pressure during weight-lifting with the trunk in the erect, stooping and prone positions, states that the intra-abdominal pressures are largest in the stooping and prone positions, so that hernias and prolapses are more likely to occur in these positions, thus offsetting the value of the increased support given to the spine.

Mechanically, too, the efficiency of a lever is greater the nearer the resistance is to the fulcrum (Figs. 2 and 3).

Fig. 2. Inefficient lever action of body. *Figs. 2 and 3 are reproduced by permission of T. McClurg Anderson and William Heinemann.*

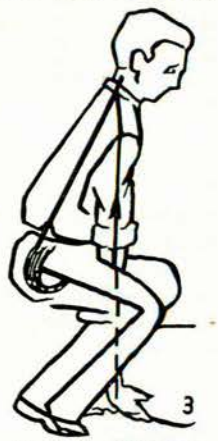

Fig. 3. Efficient lever action of body.

In other words, to hold a weight out horizontally at arm's length requires more effort than to hold it at the side, owing to the magnifying effect of the lever. With a curved back, i.e. with cantilever lifting, the turning moment or the weight of the body is not being used to counterbalance the object that is being lifted, in the important early stages of the lift.[10] The human body when physically fit is however capable of resisting great stresses and strains, in spite of bad mechanics, and this is again well shown in the African. Only in those who have become overcivilized do precautions appear to be necessary.

2. *Tucking in the Chin*

This is preceded by raising the head. It is a simple method of locking the spine (Fig. 4), confirmed by Willis,[11] who states that proper posture is most easily obtained by starting with the head, raising the crown as high as possible by retracting the chin and straightening the neck, and also by Tucker.[12]

3. *Elbows into the Side*

The arms weigh about 10 lb. apiece and if you lift up something, with the elbows jutting out from the body, a far greater strain is placed on the muscles of the arms and shoulders. By keeping the elbows tucked into the sides and by supporting the arms against the inside of the thighs when lifting from the ground, much of the strain can be eliminated (Fig. 4).

4. *Palmar Grip*

This grip involves the palms of the hands and not the finger tips. When the finger tips are used the muscles of the forearm are tense and therefore most liable to strain and fatigue (Fig. 4).

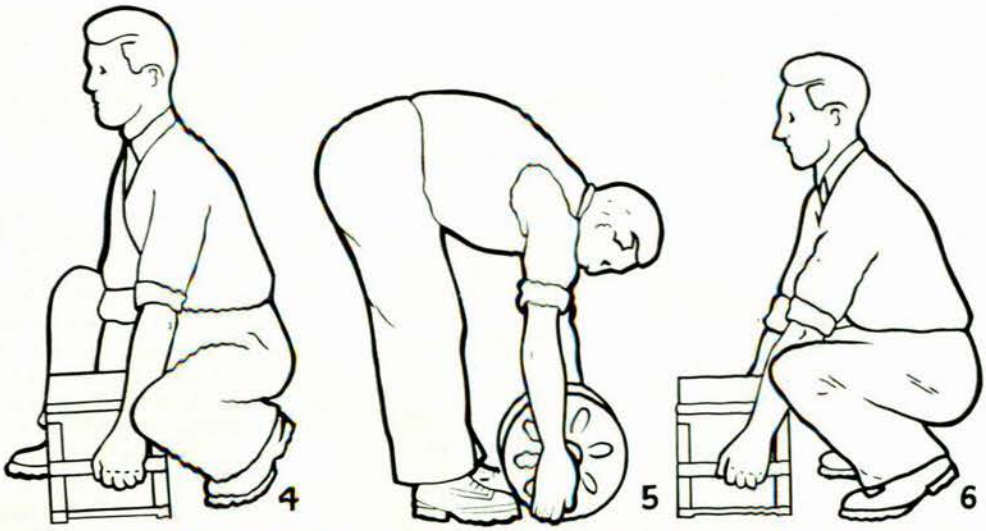

Fig. 4. The Kinetic posture when picking up a box: (1) chin tucked in, (2) back straight, (3) arms supported by thighs, (4) broad palmar grip, (5) knees relaxed, feet apart, and one placed in front of the other. *Figs. 4, 5 and 6 are reproduced by permission of Imperial Chemical Industries.*

Fig. 5. Primitive way of picking up box. The feet are together, the legs straight, and the back arched.

Fig. 6. Mechanical way of picking up box. The feet are parallel, but the back is straight and the knees are relaxed.

5. *Proper Foot Positions*

Anderson describes 3 methods of lifting, and these depend to some extent upon the position of the feet.

(*i*) *The primitive method.* Here the operator stands with his feet near each other, his legs straight and his back arched. When taking the weight he is clearly off balance forward and has no way of avoiding an accident should he slip (Fig. 5).

(*ii*) *The mechanical method.* Here the operator has his feet apart and parallel, with the back straight. The centre of gravity is better placed and the lever is more efficient, but the man is relying on the power of his strong leg muscles to do the work (Fig. 6).

(*iii*) *The Kinetic method.* In this the operator positions himself with his feet apart and with one foot in front of the other (Fig. 4). This ensures that the centre of gravity during the lift passes through a point between the feet; it provides for better balance and for protection in the case of a slip. Furthermore, it enables the operator to push off with the rear foot and therefore to make use of his body weight when lifting.

6. *Body Weight*

By using the body weight much of the strain is taken from the legs, back and arms. This is particularly well illustrated in the lowering of a drum from an erect position (Fig. 7).

Fig. 7. The use of body weight in lowering a drum.

In order to demonstrate these key factors let us go through the steps when a 50 lb. box is lifted:

1. Approach the box and position feet as mentioned above.

2. Keeping back erect and chin tucked in, relax knees and lower arms, if possible between the legs.

3. Tilt box in order to get broad palmar grip.

4. Support arms on the inner aspect of thigh.

5. Push off with rear foot and at the same time raise the box to a comfortable carrying height.

Should the operator intend to move to the left he will point his forward foot in that direction when he takes up his stance. This saves his turning on a fixed foot after picking up the object.

If the operator has to put the box on a high shelf he relaxes his knees as he approaches the offloading point and pushes off with his rear foot as he lifts the box to

a higher level. Thus the leg muscles relieve the arms and shoulders of much work.

These then are the basic or key factors of Kinetic Handling. It must be clearly understood that in many instances it may not be possible to apply all these principles rigidly. They must be adapted to the needs of the occasion and of the individual.

Kinetic methods are not confined to lifting. They can be widely adapted to many tasks in industry, in the office, and also in the home, special attention being paid to correct posture, whether standing, sitting, kneeling or lying.

Kinetic Handling was started at the Somerset West Factory of African Explosives and Chemical Industries about 5 years ago and has spread throughout the Company. There has been much opposition to it and it is difficult to say just how widely and effectively it is applied. Opponents maintain that it is a slower method of working and that in many instances it is impossible to apply the principles. Against this, we maintain that in total there is less fatigue and less strain. It is furthermore a safer method of working, the worker being better balanced and therefore better able to cope with any emergency.

The biggest argument we have to contend with is that the Europeans do not perform the manual work and therefore have no need to learn the technique; and that the Africans who do the manual work do not complain of backache and therefore it is not necessary to teach them. However, photographs taken by the author of Africans stacking 100 lb. bags reveal no uniform method of working; they tend to stand flatfooted with their feet slightly apart, bending their knees a little; some have an arched back but others are able to bend right down and yet maintain a straight back by bending at the hips. These latter men are undoubtedly the best lifters and they make considerable use of counter-balance by swaying back on their heels as they lift the bag (compare weight-lifters). There is no doubt that these methods could be improved, but that would require considerable training, which could not be justified economically. I believe that the reasons why the African does not suffer from a painful back are that he is physically fitter than his European counterpart, that he has a more flexible lumbar spine[13] with resilient and stretching muscles, that he walks a great deal and that, generally speaking, he sleeps on hard beds and sits on hard chairs. He does not spend his life in a motor car and he seldom works for more than 12 months before returning to the territories.

In a lecture to the South African Orthopaedic Association in Cape Town in October 1960, Dr. Beckett Howarth, the well-known orthopaedic surgeon from Connecticut, advanced the following reasons for the susceptibility of the more civilized peoples to low back pain: (1) The assumption of the erect posture; (2) obesity; (3) poor standing posture, with the abdomen out and the chest in, thus exaggerating the lumbar lordosis; (4) sedentary life 5 days a week followed by vigorous exercise at week-ends; and (5) unsuitable furniture, including soft beds, soft low chairs and motor-car seats.

It is obvious that one cannot change the lifting habits of a community overnight and in many instances it may not be desirable. The increasing incidence of low back complaints, whether due to acute injury or cumulative strain or of unknown aetiology, led to the Kinetic approach, as it has led to Howarth's Dynamic Posture[14] and to Tucker's Active Alerted Posture,[2] all of which are basically similar. I am convinced that the Kinetic method, if applied intelligently, and with common sense, is a practical answer to a very real problem in industry and the country as a whole.

I have no statistics to prove this. In one department, where Africans are handling large numbers of boxes of explosives per man per day, there has been no falling off in efficiency since the introduction of Kinetic methods. On the other hand, there is some evidence to show that, where high-pressure work is concerned, such as is found in the Fertilizer Department in the rush season, rigid Kinetic Handling with its increased number of movements may be slower than the so-called natural method. However, no conclusive tests have been made to prove or disprove this. The answer may lie in a compromise between the two methods, though industry seems so well pleased with the old system that change is unlikely.

The latest figures at this Factory, however, do suggest that something has been achieved. Among the Coloured and Africans there has been no appreciable change, but the European figures have shown a steady improvement since 1959. What is more significant is the fact that the improvement has occurred chiefly in the non-staff members, i.e. the artisans and process workers at whom the teaching and training programmes have been largely directed. The staff or white-collar members of the Factory have shown no improvement at all (Table II and Fig. 8).

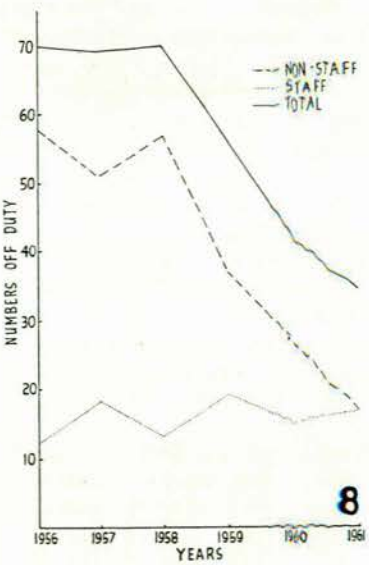

TABLE II. OCCASIONS ON WHICH TIME WAS LOST BY EUROPEANS OWING TO LOW-BACK PAIN, 1956-61

	Non-staff	*Staff*
1956	58	12
1957	51	18
1958	57	13
1959	37	19
1960	27	15
1961	17	17
	247	94

Fig. 8. Occasions on which time was lost by Europeans owing to low-back pain, 1956-61.

I believe that Kinetic methods can be widely applied in many walks of life. The nurse, who has to lift patients, make beds and do a hundred and one different tasks; the ambulance driver, the fitter and turner, the bus driver, the sedentary clerical worker and, of course, the housewife,

can all benefit. Its principles could possibly be applied in the teaching of the physically handicapped as well as to those who are sound in limb and mind. It may well be that children should be taught the system from an early age, so that it becomes second nature to them, but with it must go physical fitness and correct posture.

SUMMARY

In view of the time lost by European employees at the Somerset West Factory of African Explosives and Chemical Industries owing to low-back pain, it was decided to introduce the methods of handling materials as enunciated by T. McClurg Anderson and as put into practice at the Nobel Division Factory of Imperial Chemical Industries at Ardeer in Scotland.

The object of Kinetic methods is to prevent fatigue and strain, and great stress is laid on cumulative strain caused by the incorrect use of muscles over a prolonged period.

The 6 key factors in Kinetic Handling are the following: (1) straight back, (2) chin tucked in, (3) elbows into the side, (4) palmar grip, (5) proper feet positions, (6) use of body weight.

These factors are analysed and it is shown that individually these principles have the backing of leading medical authorities.

A brief review is then given of the work at Somerset West and the difficulties that have been encountered. A definite reduction in absenteeism due to low-back pain has been shown among European artisans and process workers. It is felt that, whatever the difficulties, the principles of human kinetics are well worth teaching, especially to the more civilized group, and that, together with physical fitness, it may be an important contribution to the solution of the problem.

I should like to thank Dr. J. P. Dalton, Principal Medical Officer, for permission to publish this article. Figs. 1, 2 and 3 are reproduced from *Human Kinetics and Analysing Body Movements* by T. McClurg Anderson, and I wish to thank the author and William Heinemann for permission to reproduce these figures.

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