A Field Study on the Use of Closed-Circuit Television as an Aid to Employment

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1. Aims

The aims of thus study were:

(i) To ascertain how well closed-circuit television aids (CCTV) prescribed as "essential to employment" were meeting the needs of individuals in their work.

(ii) To learn if modifications are desirable to improve and extend the present range of machines.

(iii) To gain information on the situations in which such aids are actually used in order to improve assessment and prescribing.

(iv) To discover what form of patient training and follow-up is desirable.

2. Background

Optical aids have long been used to augment residual vision in patients registerable as 'blind' or 'partially sighted'. Aids vary enormously in type, cost, availability and acceptability. They include simple hand magnifiers, industrial magnifiers (which often have illumination built in), spectacle magnifiers and spectacle-mounted or hand-held telescopes. Up to 20x magnification is in common use but all aids have disadvantages and demand considerable adaptation and persistence from the patient. Higher powers invariably have a small field and a very short working distance (i.e. the space between the aid and the material to be viewed).

In the United Kingdom low vision aids are occasionally purchased privately. More often an hospital ophthalmologist who considers an individual patient might benefit will refer him to a low-vision clinic or individual practitioner where the most appropriate aids can be prescribed and dispensed 'on loan'. Such aids remain the property of the

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hospital, and efficient clinics follow up patients to check that the optimum aid has been supplied. Unused aids are recovered and the aid, or component parts of it are recycled. The hardware and distribution services are fully described in the literature (Mehr & Freid, 1975; Silver & Thomsitt, 1977). There is little doubt that well motivated patients with a wide variety of diagnoses and disabilities can derive considerable benefit and be enabled to use normal materials in a normal environment (Silver, 1976).

During the last decade, CCTV techniques have added a new and exciting option. Dr. Sam Genensky led the team that did the major development work at the Rand Corporation in Santa Monica. The scene was reviewed fully in a recent paper (Silver & Fass, 1977). At least 20 different machines have been produced commercially internationally and the largest manufacturer has sold over 5000 machines.

Briefly CCTV confers certain advantages not available from optical aids:

(i) Greater magnification, from about 5x to over 60x.

(ii) the ergonomic advantages of a relatively normal reading position.

(iii) Variable magnification with zoom lenses.

(iv) Enhanced contrast.

(v) Reversed polarity - that is the capability of switching from conventional black print on white background to white on black which is preferred by the majority of patients (Mehr, Frost and Apple, 1973).

There are, inevitably, disadvantages. The aids are bulky, difficult to move about, may need frequent skilled maintenance and cost a lot of money (from a minimum of £900 in 1978). It is this last factor that has inhibited widespread use in this country. While the benefits are undeniable such aids, if prescribed through the hospital eye service, must compete with all the other demands on the hospitals limited budget, except for those

few persons able to arrange private purchase.

The Manpower Services Commission (MSC) through its 'Aids to Employment Scheme' can supply any aid that is considered 'essential to employment'. For some patients the aid might be a specially modified car, for those with a visual disability a tape recorder, braille micrometer or an Optacon.

After informal discussions between the head of the Moorfields Low Vision Clinic and representatives of the Employment Services Agency it was decided that CCTV could be included on the list and a pilot scheme was devised to supply a series of aids. It was immediately apparent that such an exercise had inherent problems, and that these were multifactorial. The MSC had a mechanism for the supply of aids to employment. Broadly, aids are supplied by Blind Persons Technical Officers or Blind Persons Resettlement Officers; 'white collar' workers are placed in employment by the Employment Services Department of the Royal National Institute for the Blind (RNIB) who may recommend that technical aids are supplied. But the group under consideration would be using sight - a new parameter for these organisations who readily acknowledge that they are in no way competent to prescribe low vision aids.

The staff of the low vision clinic at Moorfields have established considerable expertise in this clinical area and have at their disposal examples of every type of aid available in the UK. In addition some experimental and development work had been done on CCTV. The clinic had an American machine, another built by the Principal Ophthalmic Optician and had had a series of manufacturers prototypes for assessment.

This experience, while limited, was probably greater than was available elsewhere in the country; but the staff had little more than the intelligent layman's appreciation of any factors other than visual involved in the problems of the disabled in their normal work environment.

Clinical recommendations based on performance with materials brought by the patient could be made, but these might need to be modified by the actual working environment. With a limited number of machines available, decisions would have to be made on priority. Further the choice was limited to machines with agents in the UK and who claimed to have adequate service arrangements.

3. Selection procedure

It was decided to utilise existing procedures. Patients already attending Moorfields would be assessed and recommendations made to the Employment Department at RNIB. Other patients would be either referred to an ophthalmologist in the main Out-Patients clinics and thence to the LVA clinic, or if already under the care of an ophthalmologist, to the clinic directly by him. All patients whose needs could be met with conventional optical aids were, of course, supplied with those instead.

Inevitably unexpected problems arose. Several people, some completely unknown to the hospital, telephoned or wrote requesting or demanding "a prescription for CCTV". Some felt that a visit to the clinic was completely unnecessary. Others wanted to come that very day. One gentleman felt that he might find the time to come along one Sunday and was quite aggrieved at a reluctance to accommodate him. Generally the response of the patients was cooperative and constructive. After assessment a proportion suggested themselves that CCTV was not the best solution to their problem; but discussions continue in the clinic on how one handles a patient who can read 5 point print with normal reading glasses, but feels nonetheless that over £1000 worth of sophisticated hardware is 'essential'.

After clinic assessment, with the agreement of the responsible ophthalmologist, a report giving performance with optical aids, recommendations on the type of CCTV indicated, together with magnification levels, preference for high or low contrast, image reversal etc., was sent to the RNIB. The nature of the task as described and demonstrated was

given, and some 'priority' level allocated.

Another problem emerged at once as to exactly what "essential" means. Only people in employment were eligible, strictly speaking therefore no-one for whom it was absolutely essential could be working without it. A classic Catch 22 situation. To resolve this patients were described as "likely to lose his job", or "has been offered a job", or "highly desirable", or "desirable but not essential" etc. The RNIB were to verify that the job was as described and the environment suitable, they would arrange the loan of an aid for a trial period - a month was originally envisaged. If the machine did indeed prove indispensible it would be supplied on long-term loan.

When the scheme had been running for some months it became evident that the feedback that was reaching the clinic staff neither met their needs, nor gave any useful information to the manufacturers. Patients were often receiving alternatives to the machine prescribed in the clinic, and no reports were obtained on performance in the work environment. It was to fill these gaps that the present study was planned.

4. Sample and method

One of the writers (JS) had been responsible for clinical assessments. All 39 patients for whom CCTV had been recommended before August 1978 were approached and asked for their cooperation. None refused, although one wrote to say that he had lost his residual vision so he was therefore excluded. Information was given to the other writer (JG) on performance with CCTV, optical aids, recommendations and clinic priority rating.

The patients were contacted by telephone; wherever possible an appointment was made to interview the patients who had a machine at their place of work. The users were asked a series of questions. Magnification, distance from screen, image preference and manipulative skills were recorded. The machine was inspected and, when appropriate, simple adjustments were made to give improved performance.

5. Findings

Contact was not made with one patient despite considerable effort and one had retired before receiving his machine. Those finally considered were 32 males (average age 42.6 years, range 28-65 years) and 4 females (average age 37.0 years, range 25-55 years), of these 30 had been supplied with optical aids, nearly always before being considered for CCTV.

The diagnoses were:

9	patients with retinitis pigmentosa
6	cataracts or aphakia
6	macular degeneration
6	optic atrophy
3	myopic degeneration
1	diabetic retinopathy
5	others

Twenty-four patients had received a machine when contacted, and 12 were waiting. It was only possible to visit 14 at their place of work (see Table 1).

Table 1. Contact with the patients

Type of contact	Received CCTV	Not received CCTV
Visit	14	0
Telephone	10	12

The average waiting time for a machine was 6.3 months (range -1 to 13 months) but some of the 'waiting' patients had been waiting longer (see Table 2). The supply did not seem to relate to the clinic priority.

Table 2. Priority coding and delays in delivery

Priority coding	Received machines				Awaiting delivery		
	Number	Number with optical aids	mean delay in delivery months	mean time have had machine months	Number	Number with optical aids	mean time waited months
high	11	8	5.4	7.5	3	2	8.3
desirable but not essential	11	11	7.2	5.5	6	6	7.8
low or contra-indicated	2	1	6.0	6.0	3	2	10.7

Technical data on the individual machines can be found in Appendix 1. The Focus machine was not available until this study was nearly complete. Of the patients who had received their machines, half had been supplied with the type recommended at the clinical assessment (see Table 3).

Table 3. Type of CCTV supplied

Recommendation		CCTV supplied				
Type	Number	Miniviewer	RS6	Abet	Focus	None
Miniviewer	1	1	0	0	0	0
RS6	2	1	1	0	0	0
Abet	24	8	1	8	0	7
Focus	1	0	0	0	0	1
none specified	7	4	0	0	0	3
unsuitable	1	0	0	0	0	1
Total	36	14	2	8	0	12

Subjects, after a period of use, tended to select higher levels of magnification than clinical records showed to be necessary. For 5 point print, mean magnification at

work was 27.7x (range 7x - 46x) and mean magnification, for the same group, in the clinic was 17.9x (range 14x - 26x); at work the mean distance of the eye from the screen was 30.1 cm (range 10 - 55 cm). Only one patient selected a lower magnification at work than had been recorded with CCTV in the clinic, but it is interesting to note that the level actually in use (7x) is identical with that prescribed in optical form.

As expected most users preferred white letters on a black background (see Table 4).

Table 4. Image preferred on the CCTV screen

Situation	Image preference		
	White on black	Black on white	No preference
Clinic	14	6	4
Work	15	7	2

Only two users were not involved in clerical or administrative work; both were using the machine for inspection of manufactured components (see Table 5). Some people were, of course, using the machine for more than one purpose. Twenty-four patients said it would be "impossible to do these tasks without the CCTV" and 11 said "it would be difficult but not impossible".

Table 5. Applications for the CCTV machines for both users and prospective users

Application	Number
Reading printed or typed material	34
Reading tables or diagrams	17
Reading handwriting	16
Writing	13
Reading maps	4
Inspecting components	2
Reading music	1
Reading stopwatch	1
Reading vernier scales	1

Various adaptations are available for some machines and the subjects were asked which they might use (see Table 6).

Table 6. Use of adaptations for CCTV machines

Adaptation	Number
To read typewriter while in use	
moving head typewriter	0
moving carriage typewriter	18
To use a visual display unit (computer terminal with cathode ray screen)	5
For distant use (e.g. blackboard)	12
To read microfilm or microfiche	9

Fifteen patients expressed a desire for a colour CCTV but nobody felt it to be essential for their work.

The length of time the machine was actually used was often difficult to estimate since many users had the machine switched on all day but used it for a large number of short periods throughout the day. The mean estimated usage per day was 2.7 hours (range 15 minutes to 8 hours).

Fifteen users expressed a desire to move the machine from one location to another. Very few just needed to move from one room to another without going up or down stairs, therefore the problem could not be solved by mounting the CCTV on a trolley.

Nine use, or propose to use, the machine at home and, of the rest, 11 use it in a shared office. With shared offices there were often problems in locating the machine so that extraneous light did not reduce contrast; many office windows were not provided with curtains or blinds. Some users mentioned the problem of lack of privacy since colleagues could see the monitor.

No users mentioned any negative attitudes from employers or colleagues; most users said their employers were pleased with the CCTV because it resulted in improved productivity.

Very little instruction was received by the users. Some machines were delivered by the manufacturer or agent but nonetheless some users were quite unaware of the facilities available on the machine.

One user, who had not previously read ink print, would have liked a training period of one to two weeks. The vast majority would have liked more instruction in the use of the machine than they received. There was a general view expressed that a follow-up visit was highly desirable.

Nine users, who had had their machines for 5.6 months on average, reported no significant malfunctions with the machine. Of the rest, 10 had faults which

reduced the efficiency of the machine but nonetheless enabled the machine to be used. But 5 had had periods of up to 2 months waiting for repairs without the use of the machine. One patient, not included in this study as she is semi-retired, had purchased a machine but 8 months after delivery had still not had a week's satisfactory use from it.

Despite these problems, 22 said that it had kept them in employment or enhanced their promotion prospects.

6. Discussion

The distribution of diagnoses in the group bears no relation to the prevalence of disease in the visually handicapped population. In particular the large representation of retinitis pigmentosa merits comment. This may be partly explained by the excellent distribution of information to this group, but must also reflect the fact that optical aids very frequently fail to meet their visual needs. CCTV seems able to make ink print accessible to a very late stage of the disease. The low occurrence of diabetics may be due to their other health problems.

It is disturbing to find clinical recommendations ignored in half the cases. Some modifications may have been found necessary after a visit to the workplace, in other cases delivery delays may have influenced the decision, but the prescriber was not consulted before such changes were effected and patients often received machines that proved less suitable than the original recommendations might have been. The researcher conducting the visits (JG) considers himself unqualified to make any sort of clinical assessment, but his opinion was that the original recommendation was usually sound. The appearance of the Focus machine would modify some of the original decisions, and patients who had not had an opportunity of assessment with this machine might benefit from an exchange, and find a significant

improvement in their job performance.

In this sample high clinical priority does not seem to be an advantage compared with 'desirable but not essential'. It is disturbing that patients are gaining the impression that clinical assessment is a pure formality; one patient actually being loaned an aid before he had been seen in the low vision clinic.

Users are in some cases using the machine for a relatively small percentage of the time. While this may, in some cases, indicate a low level of need, it may also be a reflection of poor instruction. However we feel that quantity is not the overriding factor, rather that the aid should enable the user to improve his efficiency.

The findings indicate very strongly that the present follow-up system is completely inadequate. The purpose of follow-up is two fold:

(i) Technical.

(a) machines must be inspected and adjusted for optimum performance.

(b) the users seem to need training in the use of the machine, particulary when tasks not described at the original assessment are attempted.

(ii) Clinical. Patients should have clinical follow-up as in the case of optical aids supplied through the hospital eye service. With the present system this would involve some patients in considerable expenditure of time and money.

For an aid which has been supplied because it is considered "essential" to employment, it is appalling that long delays are occurring during which the user is presumably unable to do his job efficiently. Indeed

several had organised repairs for themselves.

It is pleasing to note that despite their disability many users consider their career prospects enhanced by the use of the machine, and others are continuing in employment where they can use valuable experience and expertise to their own benefit and that of the community.

7. Conclusions and recommendations

(i) The present system could be improved so that the needs of the CCTV users at work can be better met.

(ii) The range of machines which can be prescribed should be increased.

(iii) For those intending to use CCTV for conventional uses such as reading and writing, the prescribing should be done in the low vision clinic with the patients bringing examples of their work materials. However for special applications it may be necessary for someone to visit the place of work and report back relevant factors to the prescriber who may then modify the recommendation.

(iv) There should be a follow-up visit after 1 month to check that the machine is operating correctly and to demonstrate techniques for using the machine. Like every other low vision patient, clinical reassessment should take place once a year, but in view of the incidence of machine dysfunction the users should be visited periodically.

(v) There must be fast reliable servicing with a replacement machine being provided if a repair cannot be done on the spot.

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(ii) The Moorfields Consultants and others for referring patients to the low vision clinic.

(iii) The Manpower Services Commission and Royal National Institute for the Blind for their cooperation.

(iv) and all the patients who cooperated so enthusiastically in this study.

9. References

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Appendix 1 Technical Data

Abet

Manufacturer: Abet Equipment Co., 24 Dane Close, Kedington, Suffolk CB9 7NX, England. Tel: Haverhill 5942 & 5611.

Description: Each system comprises a camera with high power zoom lens and close-up attachment, fully adjustable stand with x-y platform, and a picture monitor with facility for positive or negative image. Reading matter is placed on the platform and the camera height adjusted to focus the image. With a simple lever on the zoom lens the degree of magnification can be selected (up to 50 times on the 12 inch monitor) and with the brightness and contrast controls on the monitor, the clarity of the resulting picture can be adjusted. An optional facility for the user is the negative image (white letters on a black background) which can be operated by a switch on the power supply unit. The monitor can be placed on either side of the camera.

Models: AVA 212 PN with 12 inch monitor.
AVA 220 PN with 20 inch monitor (used in M.E.H. Clinic)
AVA 224 PN with 24 inch monitor.

Accessories: Monitor stand which raises the entire monitor to enable full tilt and position adjustment and provides extra room for viewing bulkier material.

Miniviewer

Manufacturer: Visualtek, 1610 26th Street, Santa Monica, California 90404, USA. Tel: (213) 829 3453. UK agent: D.W. Campbell, 7 Musters Road, West Bridgford, Nottingham NG2 7PP.

Description: A lightweight (27 pounds) portable unit designed for situations where usage will be at a variety of different locations. The camera, illumination and monitor (12 inch) are an integral unit mounted over the viewing table. The zoom lens permits magnification from 4 to 40 times. A reversed image facility is provided as a standard feature. The camera is always to the right of the screen.

Accessories: Typewriter accessory allows the machine to be used with almost any moving-platen typewriter. Forward viewing feature for viewing vertical objects or papers at distances of a few feet to about 30 feet. Electronic line marker allows the user to blank out the portions of the screen both above and below the line or area of immediate concern. Electrical lock to prevent un-authorised usage. Plexiglas sheet to help when reading curved or folded surfaces. Spare bulbs.

RS-6

Manufacturer: Visualtek, 1610 26th Street, Santa Monica, California 90404, USA. Tel: (213) 829 3453. UK agent: D.W. Campbell, 7 Musters Road, West Bridgford, Nottingham NG2 7PP

Description: The RS-6 has a camera (28 pounds) separate from the monitor (c. 33 pounds). Two monitors (17 inch and 19 inch) and two zoom lens (4:1 and 5:1) are available and give magnification ranges of 4-30, 5-60, 5-34 and 6-67. A reversed image facility is provided as standard. The viewing table has margin stops and adjustable friction.

Accessories: Monitor stand which provides for tilt and position adjustment of monitor, and raises monitor to provide easier compact use. Electronic line marker (factory installed) allows users to blank out the portions of the screen both above and below the line or area of immediate concern. Typewriter accessory for use with a moving-platen typewriter. Room viewer (factory installed) permits focusing on objects in the room such as people's faces and blackboards. Supplementary viewing table (20 inches wide by 15 inches deep). Wheeled table (4 feet wide, 27 inches deep) provides convenient work area with plenty of knee space; legs fold under for easy storage. Electrical lock to prevent unauthorised usage. Plexiglas sheet to help when reading curved or folded surfaces. Spare bulbs.

Focus

Manufacturer: John Heathcoat and Co. Ltd., Tiverton, Devon.

Description: Separate camera and monitor mounted on a fixed base plate. The Focus has a simple electrical slider control with an

electrical servo system to focus the camera. For thick books the counterbalanced camera is simply lifted until the new clear point is found. Polarity is reversible and another switch will give "absolute" contrast, i.e. only blocked white - no greys. The machine can be supplied for left handed use. Foot controls may be available. Monitor will move to any position in a fixed horizontal plane and rotate, but not tilt. Magnification range 10x to 75x. Reading table has free floating X traverse and damped Y traverse. Built in illumination with automatic light level compensation incorporated in the camera electronics.

Accessories: Under development are addition of slave monitors, typewriter viewing table, magnification ranges from 2x to 200x, facility for the reception of normal TV channels, automatic focussing.

All the above information has been provided by the manufacturers, and the authors have not attempted to verify the accuracy of this information.

Suggestions for design improvements

General

1. Many users commented on the blurring when the reading table is moved quickly; this can limit reading speed.

2. A significant number of the users are left-handed and they find many of the controls badly positioned for them.

3. Some users expressed a desire for foot-operated controls.

4. Many users had problems eliminating extraneous light reflecting from the screen. A simple hood might solve this problem. The hood would alleviate the problem of lack of privacy when reading confidential documents.

5. The reading tables could be improved by having a grid drawn on a matt non-slip surface. Some users favoured having a clip for holding single sheets of paper.

6. Some patients seem to need the features of one machine but find the magnification range unsuitable. It would be helpful if alternative magnification ranges were more readily available.

7. None of the machines seemed to have a recognised certificate of electrical safety.

Abet

1. Most users had not been provided with a stand for the monitor, so these users often had difficulty in using the machine comfortably (the clinic machine has a stand and patients were expecting one).

2. The control box at the back of the reading table needs to be repositioned to be more accessible.

3. A serious problem easily solved is that the switches seem to have insufficient current rating.

4. It is difficult to move the camera vertically, particularly if it is necessary to view the screen while doing so. Many users suggested modifications such as a rack and pinion mechanism.

5. Another problem is that there is no adjustment of the friction of the reading table (i.e. the vertical should be stiffer than the horizontal). Having no method of locking the reading table, makes writing and using a typewriter difficult.

6. The illumination was frequently considered unsatisfactory; the lamp becomes too hot to touch so it is difficult to adjust.

Miniviewer

1. The small depth of focus means that the machine has to be adjusted frequently when using a thick book (e.g. when going from the index to the middle of a book). This problem is particularly serious for those using high levels of magnification.

2. The illumination was considered by many to be unsatisfactory. One specific problem was the reflections when viewing glossy materials; some users had removed the lamps and supplied their own illumination. Many users found the glare from the lamps distracting; a simple shield should overcome this problem.

3. The small distance between the reading table and the camera means that it is difficult to turn over the pages of large books (e.g. ledgers) and write or manipulate materials.

4. It is difficult to read large sheets of paper such as computer line-printer output.

5. Some users felt there was room for improvement in the positioning of controls e.g. the knobs on the side were inconvenient to use particularly for those who are left-handed.

6. Many users expressed a desire for a larger monitor but this point would not have arisen had they been supplied with the machine originally prescribed.

RS-6 and Focus

With the RS-6 and Focus, very few comments other than ones from the clinic are available.

The RS-6 is difficult to adjust for thick books. Patients complained of reflections from white or glossy materials and from the light source itself.

The Focus prototype needs a stop on the automatic focus otherwise the patients burn out the motor. Patients have commented that a different 'feel' at the neutral point on the focus slider control would be advantageous.

Footnote

Much of this material is being published concurrently in The Ophthalmic Optician.