ROTATIONAL TESTING OF VESTIBULAR FUNCTION

a report by the

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HEALTH

TECHNOLOGY

ADVISORY

PANEL

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ROTATIONAL TESTING OF VESTIBULAR FUNCTION

A REPORT BY THE

NATIONAL HEALTH TECHNOLOGY ADVISORY PANEL

Any comments or information relevant to the subject matter of this report would be welcome. Correspondence should be directed to:

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ROTATIONAL TESTING OF VESTIBULAR FUNCTION

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EXECUTIVE SUMMARY

- Computerised rotating chairs provide an additional means of diagnosing abnormalities of the vestibular system of the body.

- Three hospitals are currently using rotating chairs for routine clinical testing in Australia. Additional installations are likely in the near future.

- Rotational testing can add significantly to the diagnostic information available from existing tests of vestibular function, but would not replace them.

- There is still uncertainty as to what would be an optimum test protocol using the technology. Sinusoidal rotation at different frequencies is most commonly used but the impulsive testing procedure is preferred by some workers in this area.

- There is evidence to indicate that use of rotating chairs has a useful role in patient management, but as yet their contribution cannot be quantified.

- Rotating chairs should be used only in the context of a full vestibular testing program. They should not be used for the indiscriminate testing of patients suffering from dizziness.

- A patient throughput of 2 to 3 per day per chair seems feasible, with an all up cost per test in the region of $160-180. If rotating chair procedures were used for all persons requiring vestibular function testing (about 7 500 p.a.), the additional cost would be in the region of $1.2M - 1.4M p.a.

- The Panel considers that reimbursement for clinical use of this technology is appropriate, but on a restricted basis until further details become available on test protocols, effects on patient management and costs.

- The Panel recommends that:

    - At this stage computerised rotating chairs for clinical use should be restricted to major centres which are fully equipped for audiological and vestibular testing, and have appropriate expertise.

- Consideration should be given to providing reimbursement to these facilities to cover professional and recurrent costs associated with the use of this technology for patients undergoing vestibular function testing.

- Hospitals at present equipped with rotating chairs should be asked to provide reports to the NHTAP on their clinical performance at the end of 1987. These reports could provide a basis for recommendations on whether the technology should be more widely used.

INTRODUCTION

The use of the rotating chair for testing of vestibular function is currently under consideration for inclusion in the Medicare Fee Schedule. In this context the Department of Health has asked the National Health Technology Advisory Panel to advise on the efficacy and cost-effectiveness of the new technology.

In the course of its study of this technology, the Panel has identified the following issues, which are examined in this report:

- the clinical significance of data from rotational tests;
- whether the rotating chair can make a worthwhile addition to the diagnostic information obtained from established tests of vestibular function, particular caloric testing;
- the contribution of rotational tests to patient management;
- the role of rotational tests in relation to more costly diagnostic imaging studies;
- the most effective test protocol (e.g. sinusoidal or impulsive testing or both);
- the type of institution in which rotating chair units should be located;
- costs of this type of testing.

VESTIBULAR FUNCTION TESTING - GENERAL

The vestibular system of the body is essential for the maintenance of balance and spatial orientation. It comprises the vestibular labyrinth of each inner ear and its connections through the 8th cranial nerve to the central nervous system. If a lesion develops in the vestibular system (in the inner ear, on the 8th cranial nerve, or in the vestibular pathways of the central nervous system), it can produce the form of dizziness known as vertigo, as well as other symptoms.

Dizziness is one of the commonest conditions encountered in medicine. It can have a variety of causes. In a small percentage of cases, it is caused by a vestibular lesion, and when other possible causes have been ruled out, there is a need to test vestibular function. It is estimated that 7500 patients undergo testing of vestibular function each year in Australia.

Given the unconscious nature of vestibular function, testing must rely on reflexes associated with it. Of particular importance is the vestibulo-ocular reflex which results in an eye movement called nystagmus in response to perceived motion of the body. Several tests of vestibular function are based on the measurement of nystagmus.

Nystagmus is an involuntary movement of both eyes, characterized by a slow movement to one side and a quick corrective return to the other. If it occurs spontaneously, in the absence of motion, it indicates a dysfunction of the vestibular system. Nystagmus can also be evoked by stimuli such as postural changes, temperature changes, and rotational motion. The nature of the evoked responses can indicate whether or not an abnormality is present.

Electronystagmography is a technique for quantitatively recording nystagmus. Changes in electrical potentials associated with eye movements are detected by electrodes placed near the eyes and transmitted to a recording device. The alternating slow and fast movements give a graph with a sawtooth appearance.

TECHNOLOGY OF ROTATIONAL TESTS

Equipment

A test of vestibular function, based on nystagmus evoked by rotating the subject in a chair, has been known for many years. In the past, however, it was difficult to obtain data in a useable form from the test, which was of limited usefulness. In recent years the introduction of computer technology has enabled the development of a more sophisticated test, which can give clinically useful results. It involves precisely controlled vibration-free rotation produced by a computer controlled torque motor. Electrodes attached near the eyes of the rotated subject are connected to the same computer, which records and processes the eye velocity data.

Computer-controlled rotating chairs are now being produced commercially in the USA and Europe. For example, the Contraves Rotating Chair was developed in the USA by the Contraves Goerz Corporation on the basis of work by J W Wolfe of the US Air Force School of Aerospace Medicine. The Servo-Med chair is manufactured in Sweden.

Tests with modern rotating chairs usually use sinusoidal rotation, in which the chair is rotated in one direction with smooth acceleration and deceleration until it stops, and then rotated in the opposite direction in the same way. The tests are carried out over a range of frequencies (cycles of chair motion per second). If a test is performed over a series of frequencies which are integral multiples, it is called a sinusoidal harmonic acceleration test. Five frequencies from 0.01 to 0.16 Hz are commonly used, but higher frequencies are possible with the most sophisticated chairs. At the University of California at Los Angeles, rotational tests are performed at six frequencies from 0.0125 to 1.6 Hz (1). Some laboratories also use impulsive testing which involves measuring the response of slow phase eye velocity to a step change in chair velocity.

A rotating chair for routine clinical use may be supplied with a specially designed computer and pre-packaged software. A unit of this type automatically discards data on the fast phase of the measured nystagmus, recording only slow phase eye velocity and processing these data to produce the results used clinically. With this system the operator has no access to the raw data and little flexibility in data processing. However the system is simple to use and a computer programmer is not required.

The chair and motor can also be supplied as a separate unit without the computer. A computer is then connected and software developed by the operator. Alternatively the chair can be purchased with a computer which can be programmed by the operator. Software development by the operator is a very time consuming process but is preferable if the chair is to be used in research.

Parameters Measured

In sinusoidal harmonic acceleration testing, the parameters usually determined from chair and eye velocity data are the gain, phase shift and symmetry.

Gain is the ratio of the chair velocity to the eye velocity. It is a measure of the intensity of the response to the rotational stimulus. A high gain represents a good signal-to-noise ratio, allowing a useful test to be performed.

The phase shift is the difference in degrees of rotation between the velocity input and the eye velocity response. That is, it is the phase difference between the input and response curves, and relates to the time difference between input and response. Some reports base the phase shift on the acceleration input.

Symmetry, or preponderance, refers to the relationship between the slow-phase eye velocity response to rotation to the right and the response to rotation to the left. Ideally the two responses should be equal and opposite (symmetrical).

In impulsive testing, the computer produces a log plot of slow phase eye velocity against time, and determines the time constant of the exponential decay in eye velocity after the change in head velocity. The gain, latency and area under the curve may also be measured.

Test Procedure

In clinical tests the patient is first prepared by having electrodes placed on the skin near the eyes. This step takes about 15 minutes. The patient is then placed in the chair in a darkened booth and rotated at the selected frequencies. The patient's attention is constantly engaged by conversation or problem solving, in order to minimise suppression of nystagmus. This test requires about 45 minutes. During the test the slow phase eye velocity is recorded and can be simultaneously displayed on a video screen. The computer processes the eye velocity data and in sinusoidal harmonic acceleration testing produces plots of gain, phase and symmetry against frequency, with normal ranges shown for comparison. Analysis of the data takes about 30 minutes.

CLINICAL SIGNIFICANCE OF ROTATIONAL TESTS

Sinusoidal tests on normal subjects have shown that although the range of gain measurements is large (1), phase measurements for particular individuals show little variation from one test to another (2,3), and the range of variation from subject to subject is quite small. Average phase measurements vary little from one laboratory to another using the same equipment (3). Symmetry is less stable and may show considerable change in an otherwise stable subject (2).

In impulsive testing there is also a clearly defined normal range for time constants, and results for particular individuals are reproducible from one test to another (4,5). Again, the range of gain measurements is large (1).

Since normal patterns are clearly defined, significant deviations are readily identified. Abnormal results may arise from conditions such as endolymphatic hydrops (accumulation of fluid in the labyrinth - Meniere's Disease is a form of this condition), acoustic neuromas, vascular loop compressions of the 8th cranial nerve, central nervous system lesions, lesions caused by ototoxic drugs, and head injuries.

Abnormalities in the inner ear are termed peripheral while those in the central nervous system are called central. The term for lesions on the 8th cranial nerve varies but in this report they are considered 'peripheral'.

It has been suggested that the pattern of phase measurements in abnormal cases can give an indication of the nature of the abnormality (3). For example, if a lesion is peripheral and chronic (such as Meniere's Disease), there may be an increase in phase shift at frequencies from 0.01 to 0.04 Hz, but normal results at higher frequencies. If phase shift is increased at frequencies above 0.04 Hz, a central lesion is indicated (3). However, these differences are not always observed and increased phase shift at low frequencies has been described as indicating only vestibular dysfunction (6). For a peripheral, acute lesion (for example, from a head injury), the phase shift may be abnormal at all frequencies immediately after injury but at higher frequencies will return to normal with time (7). For unilateral peripheral lesions symmetry results can give an indication of the side of the lesion, but are often not outside the normal range and asymmetry may disappear as the central nervous system adjusts to compensate for the condition (6). Phase shifts, however, do not disappear as compensation occurs (6). With bilateral peripheral lesions, responses to rotation are symmetrically diminished. When responses are present, phase shift patterns are similar to those for unilateral lesions (6).

For a particular vestibular abnormality there can be considerable variation in phase and symmetry results from one subject to another. However, for each individual, phase shift measurements show little variation while there is no change in the abnormality. Consequently, a change in phase results over time indicates a change in the abnormality (3). This is of particular importance clinically, allowing the clinician to identify recovery or compensation processes, or the worsening of a disorder.

The Panel has not found general agreement that the best results are given by the sinusoidal test protocol developed for the Contraves chair. There is a view that impulsive testing is superior. The Panel believes it is likely that further developments in testing protocol will occur in the next few years.

In summary, rotational testing can demonstrate the presence of an abnormality, may give some clues as to its nature and will enable its progress to be followed. However, it will not on its own provide an unequivocal diagnosis of the condition and the optimum test protocol is not clear.

VISUAL TESTS ASSOCIATED WITH THE ROTATING CHAIR

It is most important clinically to distinguish between peripheral and central lesions, in order to be able to make choices on further diagnostic tests and therapeutic procedures. As indicated above, rotational testing alone is limited in its ability to make this distinction. However, overseas results indicate that tests involving visual stimuli, in conjunction with vestibular tests, can differentiate between central and peripheral lesions (1,6).

Examples of visual tests include measurement of eye movement response to a spot of light moving sinusoidally on a screen (pursuit tracking) and to a rotating striped drum (optokinetic testing). Eye movement data from such tests can be processed by the same computer used for the rotating chair. In addition, tests can be performed which combine visual and rotational stimuli. For example, if a normal subject is rotated while staring at a light, nystagmus is suppressed. A failure to suppress nystagmus would indicate the presence of a central lesion (6).

Baloh et al have reported that taken together, the results of visual, vestibular and combination visual-vestibular tests may not only differentiate between central and peripheral lesions, but may also indicate the site of a central lesion (6). They appear to provide significantly more information than either rotational or visual testing alone.

PLACE OF ROTATIONAL TESTING IN VESTIBULAR STUDIES

Vestibular studies may involve a battery of tests including simple observations of gait, pointing ability, spontaneous nystagmus, and nystagmus evoked by postural changes, as well as quantitative electronystagmographic studies. The most important of the quantitative procedures has been caloric testing.

The most common form of caloric testing is the bithermal caloric test, in which measured amounts of warm water (at 44^{o}), and cooler water (30^{o}) are brought into contact with each eardrum over a measured period. The cool water evokes nystagmus with the fast eye movement away from the stimulus, while the nystagmus evoked by warm water is in the opposite direction. These effects are believed to be due, at least in part, to convection currents induced in the labyrinthine fluid.

The parameters measured in the caloric test are the duration of response, intensity of response (maximum slow phase eye velocity), and any difference in response between the two ears (labyrinthine preponderance). The clinical information provided by these measures is rather limited, but they can be used to identify underactivity, overactivity, or complete loss of function, and to indicate which ear is involved in any abnormality detected. They may give some indication of whether the abnormality is peripheral or central.

The Torok monothermal differential caloric test is much less widely used, but has been reported to be a much more effective diagnostic test, which can more accurately distinguish between peripheral and central lesions (8). In this procedure, two tests are performed on each ear with water at the same temperature (20°) but with different volumes, for different periods, and with different head positions.

In examining the role of rotational testing in vestibular studies, the Panel paid particular attention to its relationship with caloric testing. Consideration was given to whether it provided additional diagnostic information or merely duplicated caloric testing, whether it had other advantages for the patient, whether it could be an alternative to caloric testing, or whether there was a role for both tests in vestibular studies.

From advice given to the Panel it is clear that rotational testing can add to the diagnostic information provided by calorics. In particular, the reproducibility of rotational test results, allowing the test to be used to follow the progress of patients, is a major advantage. In caloric testing, results vary not only from one subject to another, but also for the same subject from one test to another. Thus caloric testing cannot be used to follow the progress of a patient over a period of time.

A number of patients cannot be subjected to caloric tests for physiological or psychological reasons, In these cases rotational testing can be used as an alternative. The rotational test is more comfortable for patients and is much less likely to induce nausea. In addition the results are less likely to be affected by drugs, alcohol, or the patient's anxiety state, and there is less tendency for patients to suppress response.

A further advantage is that rotational motion affects the vestibular system directly, and the stimulus can be measured accurately. Caloric testing is indirect in that water temperature has to be transmitted through tissue and bone, which can have an effect that varies even from one side of the head to the other.

There is some evidence that rotational testing detects abnormalities more accurately than calorics. Preliminary examination of data obtained at the Alfred Hospital in Melbourne from a series of 325 patients indicates that the rotational test is more sensitive to the presence of a vestibular disorder than are caloric tests (9).

Pappas has reported (10) that in a series of 109 patients rotational testing alone identified abnormalities in 60%. A complete electronystagmographic examination including measurements of spontaneous and positional nystagmus as well as calorics also identified 60% (the same patients) but calorics alone identified abnormalities in only 40%. Tracking abnormalities occurred in 72%. Olsen et al (11) found that in a series of 24 patients with surgically proven acoustic neuroma, caloric examination identified 79% and rotational testing 67%, but the rotational test was more sensitive for the detection of small tumours.

It could be suggested that computer-controlled rotational tests should replace caloric tests altogether. Calorics have been critized as being of little usefulness (12), but they have also been strongly defended (8,13). At present caloric testing is the only means which allows each ear to be tested individually (1,13). It could also be argued that in an area where no single test can provide an unequivocal result, a combination of tests may improve the likelihood of a correct diagnosis.

Vestibular studies are generally not undertaken without full audiological testing, which can provide a broad indication of whether a lesion is in the inner ear or the central nervous system. In addition they are complemented by brain stem audiometry, in which surface electrodes are used to record electrical activity, generated in response to sound, along the auditory pathway from the cochlea to the cortex. Analysis of the wave forms recorded can give an indication of the site of a lesion in the brain stem or on the 8th cranial nerve.

In summary, the results of the range of vestibular and associated visual tests, taken together with patient history and audiometry, can usually allow the clinician to arrive at a likely diagnosis. In some cases observations over a period of time may be required. Particularly in these cases, rotational testing can significantly enhance the probability of a correct diagnosis.

EFFECT OF ROTATIONAL TESTING ON PATIENT MANAGEMENT

The Panel is not aware of any detailed studies of the effect of rotational testing on patient management and outcome, although there are a number of individual case studies. This evidence suggests that rotational testing can make a useful contribution to patient management.

Some of the benefit stems from improvements in the diagnostic accuracy of vestibular studies. For example, by increasing the reliability of negative diagnoses, rotational testing may reduce the need for further, costlier tests. In some cases, it may result in positive diagnoses for patients in whom abnormalities had not previously been detected, some of whom may have been subjected to unnecessary and costly psychiatric care. In others, it may show that symptoms attributed to a minor peripheral abnormality in fact have a central cause.

In addition, rotational tests can contribute to patient management through their capacity to follow patient progress over time. For example, they can be used to detect a slowly developing pathology, allowing appropriate treatment regimes to be defined. In other cases processes of recovery and compensation can be identified, giving reassurance to anxious patients. Rotational tests may indicate an inability to compensate for a vestibular condition. This would be a contraindication for surgery which would cause further destruction of vestibular function. Rotational testing can have an important role in the evaluation of candidates for vestibular nerve section (4).

However, from existing data it has not been possible to quantify the impact of rotational testing on patient management.

VESTIBULAR STUDIES AND DIAGNOSTIC IMAGING

Positive diagnosis of central lesions and acoustic neuromas arrived at through vestibular studies may need to be confirmed by diagnostic imaging (currently CT scanning). In the case of acoustic neuroma, CT with air enhancement is required, an invasive procedure with high morbidity. Vestibular studies help to reduce to a minimum the number of unnecessary scans. In the future magnetic resonance imaging is likely to be used to confirm diagnoses of acoustic neuroma and brain stem lesions (14). While the discomfort and risk for patients will be eliminated the high cost of the procedure will make it highly desirable for patients to be selected efficiently. Thus, there is a case for optimising the diagnostic accuracy of vestibular studies in order to reduce the cost of CT and MRI studies.

ROTATIONAL TESTING IN AUSTRALIA

In Australia, rotating chairs are already in routine clinical use at the Alfred Hospital in Melbourne, the Royal Prince Alfred Hospital in Sydney and the Sir Charles Gairdner Hospital in Perth. In addition, a chair used for research is at the Bethlehem Public Hospital in Melbourne.

At the Alfred Hospital, the Otolaryngology Unit has been operating a Contraves Chair for about two years. It was purchased with pursuit tracking accessories, a computer, and pre-packaged software for low frequency sinusoidal harmonic acceleration testing. Rotational testing at the hospital is an integral component of a vestibular testing program which also includes tests of spontaneous and positional nystagmus, calorics, and testing of auditory brain stem response. Two audiologists are employed full time on the program, under the guidance of an otolaryngologist. At this staffing level, two to four patients a day can be given the full range of tests. Patients are received from all over Victoria for the vestibular testing program and the waiting period is several months. It is unusual for patients to be referred from other hospitals for rotational testing only.

The Royal Prince Alfred Hospital has two rotating chairs in its Neurology Unit, and a third has been ordered. The chairs are used both for routine clinical testing and in research. One chair was built in house. The other is a Servo-Med unit purchased 4 years ago and supplied with a computer which was programmed by the operators. Tests are performed by a technologist under the guidance of a neurologist who works in close co-operation with the Otolaryngology Unit. Computer programming and back-up services are provided by engineers on the hospital staff. Some 190 patients went through the testing program in 1984. Major emphasis is placed on impulsive testing but sinusoidal tests are also performed.

Sir Charles Gairdner Hospital purchased a Servo-Med rotating chair in 1985 and routine clinical testing has only recently begun. The chair and motor only were purchased and are being connected to a computer already available in the hospital. The computer is being programmed by the operators. The chair is under the control of a neurologist who is present during tests which are carried out by a technologist. The chair is used predominantly in studies of central vestibular function, together with a range of other tests. It is expected that 8-10 patients a week will be tested when the unit is in full operation.

The unit at Bethlehem Public Hospital comprises a Templin chair and motor linked to a computer built and programmed by the engineer working on the project. It is used in neuro-ophthalmological research related to multiple sclerosis.

From comments made to the Panel it appears likely that other Australian hospitals will install rotating chairs. As yet there has been no move to install them in stand-alone clinics.

COSTS OF ROTATIONAL TESTING

The Panel has estimated the costs of rotational testing with the aim of giving a broad indication of its impact on health care costs. The results are not intended to be estimates of possible reimbursements.

The cost of rotational testing depends heavily on the capital cost of the equipment used. This will in turn depend on the choice of manufacturer, the components purchased, and the exchange rate. Other items requiring funding initially include shipping and insurance, installation, and an enclosure for the chair, which in Australia would be more economically built in-house than supplied from overseas. If the computer and software are not supplied, a suitable computer will need to be provided and programmes developed before clinical testing can begin.

Throughput will have a major influence on cost per test. In a clinical setting it would usually be impractical to operate the machine at full capacity. Rotational testing is performed as one of a series of audiological and vestibular tests, usually on outpatients many of whom may live some distance away from the unit. Generally all tests would be performed on the one day. Limited hospital staffing would make it difficult for more than 2-3 patients a day (450 - 700 a year) to be scheduled through all the tests, including rotational tests. It might however be possible to increase throughput on the rotating chair if two hospitals within reasonable proximity to one another were to share the facility.

A technologist or audiologist would normally perform the rotational tests, although at a throughput of 2-3 a day this would not be a full time duty. The remainder of this person's time could be taken up by other clinical tests or by research activities. A specialist (either an otolaryngologist or a neurologist) should be responsible for assigning patients to the rotational test, and for interpreting results. In some cases, the specialist may need to be present while the test is being performed.

Table I gives estimates of costs in a case where a Contraves chair is supplied with a computer and pre-packaged software. It is assumed that initial costs are repaid over 5 years at an interest rate of 15%, and throughput is 450 tests a year. Under these conditions the total cost per procedure of rotational testing only would be $159. The cost of a rotational test with pursuit tracking would be $176.

Costs would be increased if a more sophisticated chair were used and if software is developed in house. At a throughput of 450 tests a year, cost per procedure could be as high as $250. In such a case, however it is likely that part of the cost could be assigned to research.

TABLE I: COST OF ROTATIONAL TESTING (A) ONLY;
(B) WITH PURSUIT TRACKING

(Computer and Pre-packaged Software Supplied by Manufacturer)

Capital Costs	A $A	B $A
Purchase price of equipment	100 400	116 000
Shipping and insurance	9 500	9 500
Isolation enclosure	5 000	5 000
Installation	5 800	5 800
TOTAL	120 700	136 300
Annualised Capital Costs	34 500	38 900
Recurrent Costs pa		
Salary - technologist (0.40, 0.45 man years per year)	10 400	11 700
Space costs, power	900	900
Equipment maintenance	4 000	4 000
Computer paper, office costs etc.	1 400	1 400
TOTAL	16 700	18 000
Cost per test (at 450 test pa)		
Capital costs	77	86
Recurrent costs	37	40
Specialist fee	40	45
Electrodes	5	5
TOTAL	159	176

NOTES

(a) Estimated at the exchange rate $A1 = $US 0.695.

(b) Repayment over 5 years at an interest rate of 15%.

CONCLUSIONS

From the evidence available to it the Panel has come to the conclusion that rotational testing can make a useful contribution to the diagnosis of vestibular conditions and patient management. In comparison with caloric testing, it has the major advantage that the repeatability of results allows patients' progress to be followed. Caloric testing, however, has the advantage that each ear can be tested separately, and could not simply be replaced by the rotating chair.

However it has not been possible to quantify the impact of this technology. In addition, it is not clear to the Panel whether the optimum test protocol has been established.

Although rotational testing is not expensive compared to such technologies as CT scanning and magnetic resonance imaging, the total cost per test is significant (in the region of $160 - $180). It would add substantially to the cost of vestibular function testing in Australia, increasing it by $1.2M-1.4M a year if it were used in all cases.

To be an effective clinical tool, rotational testing must be a component of a full program of audiological and vestibular tests, involving patients who have already been through an efficient selection process. A stand-alone unit used to test dizzy patients indiscriminately would be a most undesirable development, which would have no clinical value and would be a significant cost to the health care system.

In the Panel's view, rotational testing should at this stage be restricted to major public or private centres which are fully equipped for audiological and vestibular testing, and which have the relevant medical and technical expertise. It is noted that manufacturers of rotating chairs are at present unable to provide servicing in Australia. The facilities therefore must have the resources to carry out servicing themselves, or have access to personnel with the necessary skills.

The Panel considers that reimbursement for clinical rotational testing is appropriate, but for the time being it should be restricted to use by appropriate facilities and cover recurrent and professional costs.

The Panel proposes that each Australian hospital equipped with a rotating chair should be asked to provide a report to the NHTAP on its clinical performance by the end of 1987. The report should include information on the test protocol, number of patients tested, diagnosed conditions, other tests performed, the number of diagnoses which depended on the rotational tests, and a comparison of the results from caloric and rotational testing. Where possible, visual tests and combined visual-rotational tests should be included in the programs. The hospitals' reports could then be used to assess whether wider use of the technology or different reimbursement policies would be appropriate.

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