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Quality Improvement Report

Increasing the impact of teleophthalmology in Australia: Analysis of structural and economic drivers in a state service

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Abstract

Problem: *Despite its potential to improve service provision for country patients, teleophthalmology is currently underused in Australia. There is an associated lack of cost-effectiveness data for teleophthamology.*

Design: *Retrospective and prospective hospital-based clinical audits of 5456 patients; descriptive survey of available telehealth equipment in 129 regional facilities; cost calculations for teleophthalmology, patient transfers and outreach services.*

Setting: *Primary (optometry, general practice [GP], Aboriginal Medical Service [AMS]) and secondary (hospital) sites in regional Western Australia; a tertiary hospital in Perth.*

Key Measures for Improvement: *Proportion of patients suitable for teleophthalmology; proportion of regional practices with telehealth technology; capital expenditure to equip regional practices for teleophthalmology; total savings from increased utilisation of teleophthalmology.*

Strategies for Change: *Advocacy for funding, regulatory, training and infrastructure recommendations, in order to support efficient models of teleophthalmology.*

Effects of Change: *A total of 15% and 24% of urgent patient transfers and outreach consultations, respectively, were found to be suitable for teleophthalmology, equating to a potential total cost saving of $1.1 million/year. Capital expenditure required for basic telehealth equipment was negligible for optometrists, compared to $20 500 per GP/AMS practice. Successful advocacy led to funding, training and policy changes to support optometry-led teleophthalmology for country patients in Australia.*

Lessons Learnt: *Public–private partnerships can result in significant cost-savings for the Australian health system. Targeted, evidence-based advocacy can inform government health reforms.*

KEY WORDS: *health service evaluation, Indigenous health, ophthalmology, rural health, telemedicine.*

Context

There is a gap in eye health between patients living in regional and remote Australia, and their counterparts in urban locations. Patients in remote areas suffer a higher prevalence of blinding eye diseases, much of which is avoidable, including trauma, cataracts and glaucoma.[1–3] In remote Western Australia (WA), ophthalmology coverage is up to 19 times lower than in urban Australia,[4] which might increase the risk of undiagnosed eye disease.[5] The capital city of WA, Perth, is the only centre that offers tertiary level ophthalmology services, but is over 3000 km distance from towns and communities in the far North of the state.

To address these inequities, ophthalmology services in regional WA are provided by two services: the Patient Assisted Travel Scheme (PATS)[6] and outreach eye services. The PATS provides a state-funded subsidy towards the cost of travel and accommodation for eligible patients and their escort(s), to visit regional centres for ophthalmic care. Outreach ophthalmology services, including the Lions Outback Vision program,[7] reduce the need for many patients to travel to an urban centre.

One strategy to improve access for regional and remote Australians is through the use of teleophthalmology. Teleophthalmology involves a real-time video consultation between the patient, ophthalmologist and referring provider (typically a GP). In Australia and overseas, teleophthalmology has shown promise in service delivery for rural patients,[8] reducing wait times

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and non-attendance,[9] and improving access, quality of care and outcomes.[10]

Outline of the problem

Despite upfront incentives and Medicare Benefits Schedule (MBS) items, the uptake of telehealth between GPs and specialists in WA has been low. The actual number of these consults in WA has been 74% below Commonwealth targets, or 3246 per year.[11] Reasons cited for the low uptake included (i) lack of clinical appropriateness of caseload, (ii) technology malfunction, (iii) legal and regulatory concerns and (iv) lack of administrative support.

The present study performed a cost analysis of teleophthalmology in Western Australia, and sought to identify efficient models of service delivery.

Key study measures

1. Proportion of patients suitable for teleophthalmology.
2. Proportion of regional practices with telehealth capability, and capital expenditure required to equip practices with telehealth technology.
3. Total savings from increased utilisation of teleophthalmology.

Methods

Study participants

Patients

Clinical audits were carried out for eye patients who were transferred to Perth, and those seen on outreach visits, including both adults and children. All patients were residents of regional locations in WA.

Health care facilities

Non-metropolitan optometry practices, GP practices, regional hospitals and Aboriginal Medical Services in WA were included in a technology survey.

Technology survey

A database of regional health care facilities was developed. A survey of ocular diagnostic and teleconferencing equipment was carried out by telephone interview. Each site was classified into one of three nominal categories:

1. Basic: slit lamp, tonometer and/or anterior segment camera
2. Advanced: (1) plus retinal camera and/or visual field machine
3. State of the art: (2) plus optical coherence tomography (OCT) machine.

Clinical audits

Patient trips to Perth

Patients utilising PATS Data on patient numbers, visits and costs were acquired from eight regional PATS offices in WA on patients from regional locations who visited ophthalmologists in Perth over a 12-month period from 2012 to 2013. Complete PATS data were acquired for the Midwest, Great Southern, Kimberley and Pilbara, which were used to extrapolate figures, by population, for the Goldfields, Gascoyne and Southwest.

Urgent patient transfers Data were collected on all urgent referrals to the ophthalmology department at Royal Perth Hospital (RPH), for adult patients from remote areas in WA between 2011 and 2013. Systematic sampling was used to select every third patient for individual chart review. This figure was used as the denominator for the proportion of avoidable urgent transfers.

Outreach consultations

Outreach services A clinical audit for Lions Outback Vision over 12 months from 2012 to 2013.

Pilbara outreach week Prospective audit of all patients on a week of outreach in the Pilbara region, including information on diagnosis and referral source. The total number of patients was used as the denominator for the proportion of avoidable outreach consultations.

Assessment of suitability for telehealth

For patients from audits 1B and 2B, the authors (two ophthalmologists and one optometrist, all currently working in both urban and outreach settings) used consensus decision-making to identify patients who were suitable for teleophthalmology, as an alternative to face-to-face consultation. The rationale for decision-making included consideration of the following factors:

1. Risk assessment: complexity and severity of the patient's condition, past ocular history and visual acuity in the fellow eye.
2. Local expertise: clinical skill and equipment needed for diagnosis and treatment, and the local availability of these resources.

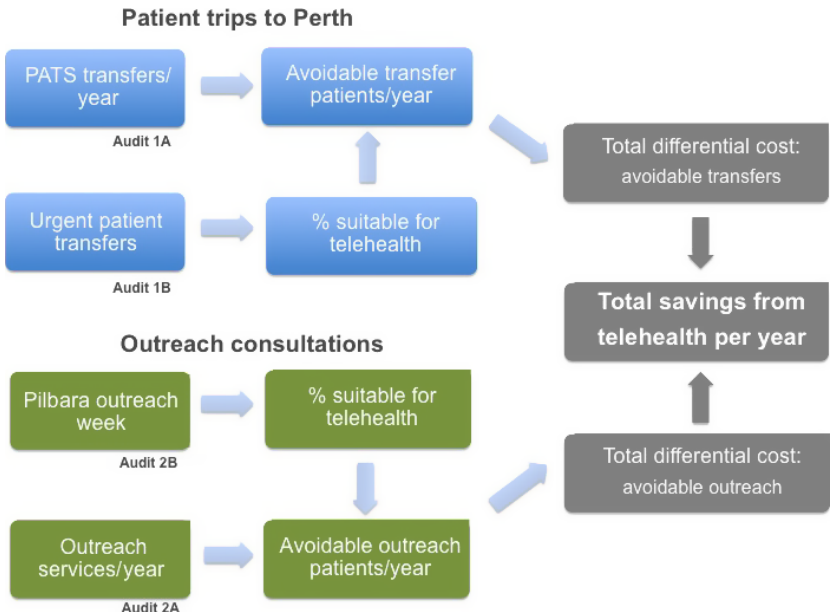

FIGURE 1: *Schematic of methodology for cost calculations.*

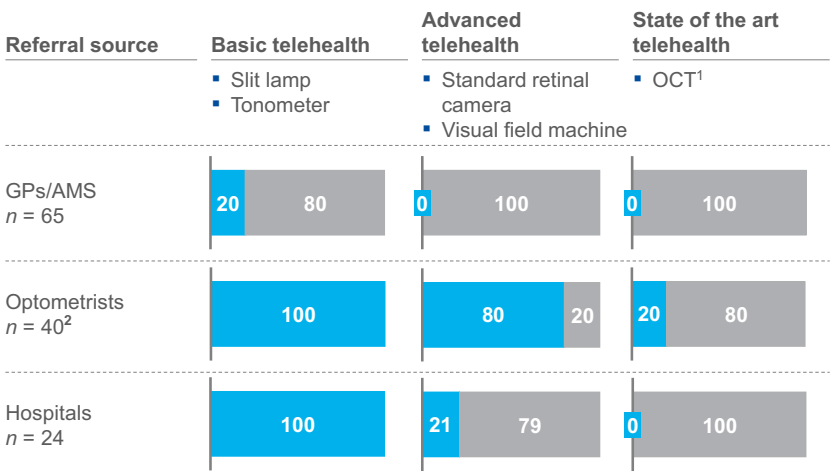

FIGURE 2: *Technology survey results. % equipped; % not equipped. GPs/AMS: General practitioners/Aboriginal Medical Services. OCT: Optical coherence tomography.*

3. Patient location: distance from Perth and closest telehealth facilities.

Avoidable transfers and outreach

The number of potentially avoidable patient trips to Perth per year was estimated by applying the proportion of urgent transfers (audit 1B) who were considered suitable for telehealth, to the total number of PATS trips in 2012–2013 (audit 1A). Avoidable outreach consultations were estimated by applying the proportion of outreach patients (audit 2B) who were suitable for telehealth, to the all patients seen (audit 2A) by outreach services in 2012–2013.

Cost analysis

The cost of a telehealth consultation was calculated from the MBS scheduled fees for ophthalmology and telehealth, an assumed imaging fee, and on-costs (administrative/coordination) of 20%. Transferring a patient to Perth was costed from data on direct (hospital consultation) and indirect (transport/accommodation, lost productivity) expenses, with assumed on-costs of 10%. Average weekly earnings are available from the Australian Bureau of Statistics.[12] We assumed indirect productivity costs (lost income and tax revenue) to be negligible for telehealth and outreach consultations, as patients are

TABLE 1: *Transfer patients assessed as suitable for teleophthalmology*

Diagnosis	Number
Lids and ocular adnexa	
Dermatochalaisis	1
Sinusitis (no orbital involvement)	1
Chalazion (non-surgical)	2
Posterior blepharitis	1
Lash misdirection	1
Shingles (no ocular involvement)	1
	7
Cornea and external eye	
Herpes simplex epithelial keratitis	2
Traumatic/recurrent corneal erosion	3
Mild chemical keratopathy	3
Mild corneal exposure/dry eye	3
Contact lens/other epitheliopathy	3
Viral conjunctivitis	3
Corneal foreign body	2
	19
Cataract and lens	
Cataract – visually significant	3
Cataract – non-visually significant	1
	4
Glaucoma	
Ocular hypertension	1
	1
Inflammatory eye disease	
Recurrent HLA-B27-positive AAU	3
	3
Neuro-ophthalmology and motility	
Microvascular third nerve palsy	1
Stable, chronic strabismus	1
	3
Retina	
Central serous chorioretinopathy (CSCR)	2
Mild dry age-related macular degeneration	1
Mild/mod. non-proliferative diabetic retinopathy	3
Posterior vitreous detachment	2
Chronic epiretinal membrane (non-surgical)	1
	9
Miscellaneous	
Pulmonary tuberculosis (no ocular involvement)	1
Migraine (no ocular involvement)	1
Bilateral pseudophakia (normal examination)	1
	3
TOTAL	48

substantially closer to home when compared with transferring them to Perth. The cost of outreach consultations in Western Australia was available in the literature.[13] A differential cost per episode of care was calculated for teleophthalmology versus patient transfers and outreach consultations (Fig. 1).

The capital expenditure required to equip regional practices for teleophthalmology was derived from publicly available information on diagnostic equipment and the technology survey. The results of the technology survey were used to calculate the total cost of providing practices with equipment that they do not currently possess, for each category of technology (basic, advanced and state of the art). The cost of higher levels of technology assumed the cost of providing more basic equipment, for example expenditure for state-of-the-art technology included the cost of providing basic and advanced equipment.

Statistical analysis

All statistical analysis used Microsoft Excel (2011), version 14.1.0 (110310), Microsoft Corporation, CA, LA USA.

Results

Technology survey

A total of 65 GP/AMS practices, 40 optometry practices and 24 regional hospitals were surveyed. Optometry practices were the best equipped (Fig. 2).

Clinical audits

Patient trips to Perth

Patients utilising PATS There were 4923 trips to Perth ophthalmologists for 2722 patients from regional WA.

Urgent patient transfers A total of 816 patients were referred to RPH for urgent ophthalmology review. Systematic sampling produced a first subset ($n = 272$). Ninety-nine patients were excluded due to inadequate documentation, non-attendance or inpatient referral. This left a second subset ($n = 173$).

Outreach consultations

Outreach services Ophthalmologists performed a total of 2253 outpatient episodes of care in 23 weeks of outreach in WA in 2014.

Pilbara outreach week A total of 209 episodes of care were performed, of which 40% ($n = 84$) were referred by an optometrist or regional hospital.

TABLE 2: *PATS data for 2012-'13*

Region	Population	Patients transferred	Number of trips	Trips/1000 population	Mean cost/trip ($)	Total cost ($)
Midwest	52 947	319	567	10.7	257.06	145 755
Great Southern	55 350	641	1155	20.9	152.62	176 279
Kimberley	34 786	271	410	11.8	810.99	332 509
Pilbara	59 896	298	585	9.8	704.95	412 396
Gascoyne	9282	54	99	10.7	258.13	25 555
Southwest	72 883	822	1521	20.9	152.61	232 118
Goldfields	57 403	317	586	10.2	480.95	281 834
Total plus on-costs (10%)	342 547	2722	4923	15.3	358.94	1 767 091

Patients assessed as suitable for telehealth

Of the 173 patients transferred to RPH, a total of 48 (28%) were assessed as being suitable for teleophthalmology (Table 1). After accounting for available telehealth equipment and other factors, this became 26 patients (15%). Of the patients seen on Pilbara outreach, 51 patients (24.3%) were assessed as suitable for telehealth.

Avoidable transfers and outreach

An estimated 738 transfer patients (15% of total), and 547 outreach consultations (24%) would have been avoidable over a 12-month period.

Cost analysis

Mean cost estimates per patient were $213 for a telehealth consultation, $444 for an outreach consultation, and $1589 for a patient transfer to Perth, giving a differential cost per patient of $231 and $1375 respectively (Tables 2, 3). This translates to total differential costs per year of $1 014 750 and $126 357 for patient transfers and outreach consultations, respectively, and a combined saving of direct and indirect costs of $1 141 107 per year. Excluding the indirect productivity costs of patient transfers (lost income and tax revenue forgone) gives a cost saving of $604 808 per year to the health care system.

The total capital expenditure required to provide basic telehealth equipment to GP/AMS practices without telehealth capability ($n = 52$) was $1 066 000. As optometrists already had some of the equipment in place, they required the least capital expenditure overall (Table 4).

Analysis and interpretation

More effective utilisation of existing telehealth facilities in Western Australia (WA) for eye patients could save a total of over $1.1 million per year in avoidable costs to society. By excluding indirect costs from the analysis, the saving to the health care system alone is an estimated $604 808 per year. Based on retrospective audits of 5456 eye visits, an estimated 15% and 24% of urgent transfers and outreach consultations, respectively, might be manageable by teleophthalmology. The real-world savings from improving telehealth uptake are likely to be higher than our projections, as this study tended towards underestimates (Table 5).

Optometry practices in regional WA are best equipped for providing primary eye care, and require the least capital expenditure for teleophthalmology capability. Optometrists can have therapeutic prescribing rights for eye medications, and already co-manage many eye patients with ophthalmologists. For these reasons, optometry-led referral is the most efficient model for teleophthamology in regional WA. Strategies to incentivise and sustain telehealth referrals from regional optometrists are therefore needed. These could include reimbursement via an MBS fee for all referrals, and consideration of an upfront 'on-board' fee for first referrals, similar to that made available by the Federal government for GPs in 2011.

In contrast with optometrists, there does not appear to be a compelling economic case for equipping GP practices for teleophthalmology capability. Few GP practices possess teleophthalmology technology, making it more costly to provide them with the necessary equipment. For example, basic teleophthalmology requires a slit lamp and a tonopen, which would cost an estimated $20 500 per GP practice, versus no extra cost for optometry practices. Furthermore, most GPs would require additional eye-specific training in order to use and maintain ocular diagnostic equipment, whereas these skills are mandatory in most optometry practices.

As such, regional GPs might be better placed to refer some eye patients to local optometrists, for the provision of primary eye care or consideration of teleophthalmology referral. This requires coordination

TABLE 3: *Cost estimates for teleophthalmology, outreach and patient transfers*

Category	Item	Cost ($AUD)
Teleophthalmology	Referrer's fee	47.10
	Ophthalmology consultation	70.00
	Specialist telehealth fee	35.00
	Telehealth coordinator	30.00
	On-costs (20%)	30.42
	Total cost per teleophthalmology consult	212.52
Outreach consultation	Great Southern	411.10
	Pilbara	419.90
	Kimberley	496.30
	Mean cost per outreach consultation	443.76
Patient transfer	Travel and accommodation (PATS)	358.94
	Lost patient earnings (2 days)	656.48
	Tax revenue forgone	150.18
	Patient out-of-pocket expenditure	200.00
	Public hospital outpatient consultation	223.00
	Total cost per patient transfer	1588.60

TABLE 4: *Estimates for capital expenditure to equip regional facilities with teleophthalmology equipment*

	Basic		Advanced		State of the art	
	Item	Cost ($)	Item	Cost ($)	Item	Cost ($)
GPs/AMS	Slit lamp	806 000	Camera	1 950 000	OCT	4 875 000
	Tonometer	260 000	VF	1 625 000		
	Total	1 066 000		4 641 000		9 516 000
	Per practice	20 500		71 400		146 400
Optometrists	Slit lamp	0	Camera	240 000	OCT	2 400 000
	Tonometer	0	VF	200 000		
	Total	0		440 000		2 840 000
	Per practice	0		55 000		88 750
Hospitals	Slit lamp	0	Camera	570 000	OCT	1 800 000
	Tonometer	0	VF	475 000		
	Total	0		1 045 000		2 845 000
	Per practice	0		55 000		118 500

GPs/AMS: General practitioners/Aboriginal Medical Services. VF: visual field machine. OCT: optical coherence tomography machine.

of services between GPs, optometrists and ophthalmologists, based on up-to-date knowledge of service providers, regional facilities, IT and administrative support. Improving the coordination of outreach eye services has been shown to improve efficiency, particularly for Indigenous patients, without increasing costs.[4,14,15] Appointing a dedicated coordinator for teleophthalmology should be considered by state health services. Safety and quality of teleophthalmology in Australia could also be enhanced by evidence-based professional guidelines, in keeping with best practice guidelines for telehealth from other Australian medical colleges.[16,17]

There are limitations to our study. We used systematic sampling of patient case notes, and records were excluded for almost 100 patients. Consensus decision-making on suitability for telehealth was performed by eye care specialists, and did not involve GPs or emergency medicine physicians. There is little existing literature for comparison of the accuracy of our estimates. There was no way of accounting for patients who needed several trips for multiple consults, as this detail

TABLE 5: *Study parameters that tended towards underestimating results*

Audit	Parameter	Implications for estimates
PATS (audit 1A)	This audit used PATS data to estimate the number of patient trips from regional areas to ophthalmologists in Perth.	Not all patients are aware of or utilise PATS. Therefore the true number of patient trips to Perth is unknown, but higher than the PATS figures. The total differential cost for patient transfers of $1.1 million is therefore an under-estimate.
Outreach patients (audit 2A)	Nine ophthalmologists provide separate, independent outreach in WA, for which audit data is unavailable.	The true number of outreach consultations in WA is unknown, but higher than 2253. The differential cost (telehealth vs. outreach) of $0.13 million is therefore an under-estimate.
Patient transfers (audit 1B)	This audit only included urgent referrals to ophthalmology; semi-urgent and non-urgent referrals were not included.	Less urgent patient referrals are usually for chronic conditions (e.g. cataracts, diabetes, glaucoma), which are often suitable for telehealth. The proportion of patients who were suitable for telehealth (15%) is likely to be an under-estimate.

TABLE 6: *Summary of recommendations for enhancing the utilisation of teleophthalmology in Australia*

Item	Recommendations
Funding	An incentive to encourage and sustain teleophthalmology referrals by optomterists for country patients. An upfront 'on-board' incentive could also be considered.
Support from professional bodies	The RANZCO and Optometry Australia (OA) to co-facilitate an optometrist-led telehealth pilot. Evidence-based guidelines for teleophthalmology to be collaboratively developed.
Coordination and training	Designation of statewide teleophthalmology coordinators. Provision of support and training for telehealth providers.
Regulatory framework	Regulations that provide for practitioner indemnity will be required to facilitate the uptake of telehealth. Professional indemnity organisations will need to acknowledge changes in scope of practice and privacy.
Telehealth technology	Some optometrists will require an upfront investment in equipment required for telehealth. If incentive payments are in place, optometrists could purchase telehealth equipment themselves.

was not available from PATS offices. And the technology survey was limited to practices in regions visited by Lions Outback Vision.

Strategy for change

Based on our findings, a strategy document was created with recommendations for teleophthalmology in Australia (Table 6). This was submitted to the Royal Australian and New Zealand College of Ophthalmologists (RANZCO) and Optometry Australia (OA). A consultation process ensued with the State and Federal Departments of Health, with pro-bono support from a professional consulting group and a legal firm.

Effects of change

Successful advocacy resulted in:

1. Endorsement of the strategy document by the RANZCO and OA.
2. Federal government approval of new MBS items for telehealth referrals from optometrists for country patients.
3. Appointment of a Telehealth Coordinator for Eye Health by the WA Health Department for a 12-month pilot program.
4. Support from the RANZCO to develop online educational modules on telehealth for ophthalmologists.

Lessons learnt

Supporting referrals from optometrists is an important step in enhancing the uptake of teleophthalmology for country patients. The impact of translational research was enhanced by partnership with a professional consulting group and legal firm. Further research, ideally as a randomised controlled trial, is needed into case selection, patient safety, long-term follow-up and costs.

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Author contributions

H. R.: study design, literature search, data collection, statistical analysis, and manuscript writing. S. P. C.: data collection, literature search, and manuscript review. A. W. T.: study design and manuscript review.

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