LASER RESURFACING OF THE SKIN FOR THE IMPROVEMENT OF FACIAL ACNE SCARRING

A West Midlands Development and Evaluation Committee Report

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About West Midlands Development and Evaluation Service

The West Midlands Development and Evaluation Service produce rapid systematic reviews about the effectiveness of healthcare interventions and technologies, in response to requests from West Midlands Health Authorities. Each review takes 3-6 months and aims to give a timely and accurate analysis of the available evidence, generating an economic analysis (usually a cost-utility analysis) of the intervention accompanied by a statement of the quality of the evidence.

About InterDEC

West Midlands DEC is part of a wider collaboration with three units in other Regions (the Trent Working Group on Acute Purchasing, the Scottish Health Purchasing Information Centre and the Wessex Institute for Health Research and Development) to share the work on reviewing the effectiveness and cost-effectiveness of clinical interventions. This group, "InterDEC", shares work, avoids duplication and improves the peer reviewing and quality control of these reports.

Contributions of Authors

Rachel Jordan undertook the research and production of the report, guided by Carole Cummins who also extracted data and made substantial comment on the content and presentation of the report. Amanda Burls helped refine the question and instigated the Dermatologists' Questionnaire, making comments on the final draft of the report before submission to external peer review.

West Midlands Development and Evaluation Committee Recommendations

The verdict of laser resurfacing of the skin for the improvement of facial acne scarring was :

4-A INSUFFICIENT EVIDENCE

but provision of the service would be supported for patients being entered into future randomised clinical trials designed to evaluate the procedure.

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LASER RESURFACING OF THE SKIN FOR THE IMPROVEMENT OF FACIAL ACNE SCARRING

Executive Summary

- **Technology**
  Acne scarring is increasingly being treated in the United States (and occasionally in the UK) by resurfacing the epidermis and upper dermal layers of the skin. The use of lasers has greatly improved the precision of resurfacing treatments by allowing depth of ablation to be finely controlled. Risks to patients (chemical toxicity and mechanical damage) and risks to medical personnel (potential infectious particles) have been reduced. Two lasers now in use for resurfacing treatments are the carbon dioxide laser and the Erbium:YAG laser.

- **Condition**
  Acne scars can result from healing of acne vulgaris lesions. More than 99% of the population experience acne vulgaris during their lifetime, usually during adolescence or early twenties, of varying severity and duration. The data on prevalence of scarring are limited, but it is likely that around 1% of the population will have scarring after the conclusion of their active acne. In the West Midlands, among the population aged 15-44, this would amount to 22,000 men and women. Data regarding the distribution of scar severity are scanty, and the psychological effects produced by facial disfigurement are not known, but West Midlands dermatologists estimate that at least 175 people per year could benefit from facial resurfacing, were there an effective treatment.

- **Evidence of effectiveness**
  Current primary evidence of the effectiveness of laser resurfacing is of very poor quality. There are no randomised trials and information is only available from small case series that do not provide good estimates for the main benefits or disbenefits. In addition, there is no good research evidence about the psychological effects of acne scarring, although there is good evidence for the psychological effects of active acne.

- **Economic analysis**
  Costs of the resurfacing procedures were provided by Lasercare, a private organisation that caters for many of the Extra Contractual Referrals in the region. Laser resurfacing is not currently provided in NHS clinics. A high degree of uncertainty is attached to the base values for effectiveness used in the economic analysis, but even allowing for extreme values for each effect, modelling indicates that the cost per QALY is likely to be less than £3000.

- **Conclusion**
  Poor quality evidence indicates that there is some improvement of acne scarring with laser resurfacing techniques. There is not enough evidence to compare the two types of laser adequately; randomised controlled trials are needed to compare the impact of treatments on patient quality of life.

1. Introduction

In 1997, a West Midlands health authority received several requests for extra contractual referrals to private clinics for the treatment of acne scars, using the carbon dioxide laser. The cost-effectiveness of carbon dioxide laser therapy for acne scars was not known.

Historically, acne scars have been treated individually or, for widespread scarring, by general resurfacing of the facial skin using deep chemical peels or dermabrasion. Both general methods have problems of precision, control and adverse effects (such as toxicity or infection risks from aerosol particles). Recently, lasers have been introduced as a new resurfacing technique. Lasers have greater precision and control, and more acceptable risks. This review addresses the cost-effectiveness of lasers in the resurfacing of acne scars. In practice, this involves the carbon dioxide laser and the newer Erbium:YAG laser.

2. Background

2.1 Aetiology and pathology of acne scars

Acne scars occur as a result of damage to the skin during healing of active acne lesions. There are different types of acne scar. 80-90% of people with acne scars have atrophic scars or ice-pick scars[1]; atrophic scars are broad, shallow saucer-like indentations and ice-pick scars are frequently deeper with sharp, steep sides. Raised scars are associated with increased collagen and are much rarer, including hypertrophic scars (in 6%) and keloid scars (in 2%) which sometimes reach more than 1cm in diameter[1]. A patient might have one or more types of scar occurring in the same skin area.

Active acne (*acne vulgaris*) which may lead to the development of acne scars in severe cases, is a widespread disorder affecting individuals primarily during adolescent years, although it can occur during the twenties and thirties or even later in life. It is characterised by papules, pustules and comedones on the face, chest, shoulders or upper arms which result from a combination of abnormal and excessive sebum production from the sebaceous glands, a bacterium called *Proprionibacterium acnes* and other abnormalities of the skin leading to the blockage of the pilosebaceous ducts. Acne varies in severity from minimal comedones and non-inflammatory pustules to inflamed, nodular and cystic lesions[2-7]. Acne may be controlled by topical skin preparations e.g. benzoyl peroxide, antibiotics and retinoids, or oral antibiotics[8]. Some will require treatment with isotretinoin, an oral retinoid.

Active acne has deep psychological effects on some individuals[9-11] which do not necessarily correlate with the visual deformity apparent to the physician[11]. There is some evidence to suggest that reduced academic achievement and employment opportunities are associated with people who have acne[9], as well as general social difficulties. The psychological effects of acne scarring are not well documented, although they could cause similar problems to other facial disfigurements. A study in Leeds is currently underway to assess the psychological effects of acne scars (Seukeran, D. Personal communication).

2.2 Treatment of acne scars

Treatment of acne scars has traditionally achieved limited success. Individual scars can be treated by punch biopsy followed by closure or filling with grafted dermis, fat, polysaccharide matrix or collagen[12; 13]. All of these methods are time consuming and

imperfect – the filled areas may remain raised or depressed compared with the surrounding normal skin, and may need planing afterwards[14]. They are often temporary[12]. Small areas of scarring can be treated by surgical excision, creating a line scar which can be aligned with natural facial creases to improve the appearance[13; 15]. Treating individual scars and small areas is very time consuming and is not considered effective by local dermatologists. Patients with larger areas of scarring can be treated by resurfacing the whole face or by cosmetic unit. Often, a combination of the above techniques is used.

Resurfacing involves the removal of the epidermis and upper dermis without extending beneath the skin appendages (sebaceous glands, hair follicles and sweat ducts), thereby allowing regeneration of the skin and also promoting collagen production[16; 17]. Resurfacing is generally more suitable for the skin of the face as the face has more appendages and therefore is more capable of regenerating than the skin of the back or chest[16]. There are three general methods of resurfacing. Deep chemical peels use a strong acid such as phenol or trichloroacetic acid which is painted over the face and removes the skin in a generalised way. Although this method is very cheap, the depth of peel is operator dependent[16; 18]. If the skin is removed to a greater depth than the skin appendages there is a risk of scarring subsequent to the treatment[16]. Another disadvantage of widespread application to the skin is the risk of systemic absorption and cardiac toxicity[16]. A second method of resurfacing is dermabrasion, which involves the removal of skin using a rapidly rotating wire brush or diamond fraise. This method is also very operator dependent because the depth cannot be finely controlled; the face becomes covered in blood so that visualisation of the original scars and the depth of treatment is impossible. There are infection risks to medical personnel as the blood droplets can remain in the air for about 48 hours[16; 18].

The most recent method of resurfacing to improve acne scarring is by laser treatment, which has the potential to be more precise and controlled compared with previous resurfacing techniques. Lasers are less operator dependent, the procedure can be better visualised and damage to the surrounding skin areas limited. They are identified by the gain medium with which the light source is intensified. Facial resurfacing has been carried out using the carbon dioxide laser and the Erbium YAG (Er:Yag) laser.

The carbon dioxide laser emits light at a wavelength of 10,600 nm in the far infra-red spectrum[18]. This radiation is absorbed totally in a depth of 0.1-0.2nm water and is therefore suitable for targeting and vapourising cutaneous tissue because the skin cells are composed of 85-90% water[16]. The laser may be controlled by the operator using a handpiece, or by a computerised scanning device which can remove skin to a specific and uniform depth[19]. The haemostasis caused by the laser produces a bloodless field and therefore good visualisation[19]. The carbon dioxide laser is available in a high-energy superpulsed or a very fast continuous form, both of which act faster than the thermal relaxation time of the skin[18; 19], thereby maximising the specific effect but minimising damage to the surrounding areas.

The Er:YAG laser emits light at a shorter wavelength (2936 nm) than the carbon dioxide laser so that the laser energy is thirteen times more strongly absorbed by the water within the skin cells[20]. This laser is also pulsed so that damage to surrounding areas is kept low; however haemostasis is not complete – pinpoint bleeding occurs at the dermato-epidermal junction[21; 22]. The Er:YAG laser can also be controlled either by a handpiece or computerised scanning device. It is thought that the Er:YAG laser may be less effective in ablating the skin, but might have a better side-effect profile[23], although this is not proven.

The disadvantages of all resurfacing techniques are that very deep scarring, particularly ice-pick scarring, may not be vastly improved[16], the procedure of resurfacing can be traumatic and painful[24] (requiring a local or general anaesthetic), [19]the skin will be erythematous (red and swollen) for several weeks[24-32], there is potential for both bacterial and viral infection[27; 31], aftercare is quite restrictive[19] , further scarring is possible[19; 24], and in some skin types hyper or hypopigmentation can occur[19]. Resurfacing procedures are not used for hypertrophic and keloid scars owing to the high risk of recurrence of scarring in these scar types[19].

2.3 Prevalence and incidence of acne and acne scarring

The prevalence and severity of acne scarring in the population has not been well studied, although it is probably related to severity of initial acne [1]. A study in Leeds of 2133 volunteers aged 18-70 from the general population[3] showed 0.7% of people to have acne scars (these were of the ice-pick atrophic type), although only 0.1% (1 in 7 of acne scarred people) were considered to have "disfiguring scars". This agrees with other observations suggesting that 80-95% of people who attended dermatology clinics with acne (likely to have at least moderate acne and about 1% of the general population[6]) showed some degree of scarring[1; 33; 34] (table 1). 80-90% of acne-scarred subjects had ice-pick and/or macular atrophic facial scars[1]. Hypertrophic and keloid scars on the face were much rarer (6% and 2% respectively). The degree of scarring (quantified by lesion type and count and allocated a score) increased with both initial acne grade and duration of acne, although it is not clear what proportion of people had severe scarring which would require intervention.

The prevalence of acne in the general population has not been frequently assessed, and studies differ in terms of design, subjects examined and criteria for acne. There are no cohort studies that measure the lifetime incidence of acne, that is the proportion of the population that has ever had acne. This cumulative measure would be the most useful for estimating the proportion of the population who will be left with residual acne scars because although active acne is temporary, any resulting scars will be permanent. Cross-sectional prevalence studies in which adolescents in the 16-18 age-group (the age of highest prevalence[2; 3; 6; 35] were examined by dermatologists indicate that the prevalence of at least minimal acne in this age group is 88-99%[2; 3; 5; 6]. It is therefore likely that almost everyone will have at least minimal acne at some stage.

Determining the severity of acne in the population is complicated by the use of different scales, most of which rely on the description and count of types of lesions present. The most relevant study in the UK[6] used the Leeds technique[36] to grade acne severity in Scottish school children, taking 2014 randomly selected children from 15 secondary schools grouped by socioeconomic status, to ensure proportional representation. Each child was examined by two independent examiners. The Leeds scale from 0 (no acne) to 10 (the most severe acne) was grouped into "no acne", Grade 0; "minimal", Grade 0.05-0.375; "mild", Grade 0.5-1.5; "moderate", Grade 1.75-3.75; and "severe" acne, Grade 4-10. At age 16, none of the children had severe acne, 1% had moderate acne, 88% had mild or only minimal acne (usually classed as clinically unimportant[3]) and 12% had no acne. In general, acne was more severe in boys than girls. Table 2 shows prevalence studies and grades of acne, tabulated against the Leeds scale[36]. Acne severity appears also to have declined markedly since 1971[2; 4; 6]; probably due to better treatment such as isotretinoin.

Table 3 gives estimates of the likely burden of acne and acne scarring in the population. Applying these values to the West Midlands suggests that 22,092 (1% of the population[37]) men and women aged 15-44 (assuming that resurfacing is required mostly from this age-

Table 1 Prevalence of acne scarring

Author/population	Assessment	Numbers of patients/age	Scarring definitions	Prevalence and severity
Cunliffe 1997/Ortonne 1997[33; 34] Patients receiving isotretinoin - international conference	Reported by Dermatologists	n = 1000 age = not stated	Not defined	Of those with moderate acne (no definition), 81% had scarring (no details of severity) and 83% had psychological problems (again no definition).
Layton, 1994[1] Leeds acne dermatology patients whose grade improved to < 0.25.	Scarring quantified by scoring system based on lesion count and type. The same observer was used.	n = 185	**Scar type** **Ice-pick** (deep/superficial scars with irregular border, jagged edges, sharp margins, steep sides, non-distensable fibrotic base) **Macular atrophic** (soft distensible scars often with wrinkled base) **Follicular Macular atrophic** (small white perifollicular lesions which may or may not be palpable) **Keloidal** (raised discrete indurated lesions extending beyond the boundaries of original acne lesion) **Hypertrophic** (less raised scars conforming to the area of the original acne lesion)	Scars on the face were evident to some degree in 95% of patients. 91% had ice-pick scars, 80% had macular atrophic, 0 had FMA, 5% had hypertrophic and 2 % keloid scars. Degree of scarring increased with initial acne grade and duration of acne

Table 2 Prevalence of acne tabulating against the Leeds scoring system[36]

	Leeds technique (Burke) Grade		0	0.05	0.1	0.175	0.25	0.375	0.5	0.75	1.0	1.25	1.5	1.75-3.5	4-10
Author/ Population	**Assessment**	**Numbers of patients/age**	**Prevalence and severity of acne**												
Rademaker 1989[6] Glasgow schoolchildren	2 independent examiners. Using Leeds technique.	n = 278 age 16	No acne	Increasing comedones & *non*-inflammatory pustules					Increasing numbers of comedones & inflammatory papules and occasional pustsules					Increasing numbers of comedones, inflammatory papules and pustules	Increasing numbers of pustules,nodules and cysts
			No acne	<u>Minimal</u> acne					<u>Mild</u> acne					<u>Moderate</u> acne (ie clinical)	<u>Severe</u> acne
			12%	77%					11%					1%	0%
Cunliffe 1979[3] Volunteers from Leeds (general population)	Probably examined by dermatologists	Total group n = 2133 Age 18-70 Age 18 (n = 166)	In age 18 5%	Up to 10 non-inflamed and inflamed lesions - physiological acne not requiring clinical treatment. 64% in age 18										Clinical acne requiring treatment, ranging from superficial inflamed lesions to nodular and cystic lesions. 29% in age 18. NB SCARS seen in 0.65% of whole group – ice-pick atrophic. 3/2133 had severe disfiguring = 0.1% of population, although this was subjective.	
*Lello 1995[5] Auckland senior high school students	Examined by a trained nurse/GP/dermatologist. Using a modification of the Leeds technique.	n= 868 Age mainly 16-18	None No acne or less than 5 lesions 15.6%	<u>Mild</u> acne. 5-20 comedones & no inflamed lesions 22.2%					<u>Mild-moderate</u> acne. 21-50 comedones confined to the face. Less than 5 inflamed lesions. 23.1%			<u>Moderate</u> acne. 5-29 inflammatory lesions on face. 5 or more lesions on back, chest or shoulders. 22.9%		Moderate-severe acne. 30-100 inflammatory lesions. Pustules or papules. Any nodules. 12.4%	3.8%
Stern, 1992[7] US (1971-74)	Cutaneous examination from the National Health and Nutrition Examination Study. Examined by dermatology residents	n = 8328 age 15-44 Prevalence is reduced in this group because of the wide age-range	71%	<u>Minimal</u> acne (including comedones and superficial small inflammatory lesions) 19%										<u>Moderate</u> (comedones, small pustules and deeper inflammatory lesions) 9%	<u>Severe</u> (extensive secondarily infected cystic acne) 1% NB Scars in 6% of those with active acne
Kilkenny 1997[35] Victorian school students	The Victorian Adolecsent Health Survey. Self reported acne severity.	n = 657 Age 16.5	9%	<u>Mild</u> acne (never/sometimes having acne on the face) = 65%. <u>Moderate</u> acne (often having acne on the face) = 35%. These categories are rather vague. NB students with moderate acne were more likely to report higher levels of psychiatric symptoms. (again vague)											
Burton 1971[2] School children in Newcastle (3 neighbouring schools)	2 independent dermatologists examined each child according to a 5 grade scale	n = 133 Age 16-18 (this was part of a larger group but these ages were chosen for comparison)	None Grade 0: No acne 1%	Grade1: insignificant comedones 32%					Grade 2: <u>mild</u> acne – a few comedones/papules/pustules. ?clinical acne? 37%					Grade 3: <u>moderate</u> acne – prominent lesions 20%	Grade 4: <u>severe</u> acne often with cysts 3.2%
Fellowes 1981[4] White school children born in 1962 in Newcastle	Acne examined (no details about observers) and classified using the Burton scale, with 4 grades	n = 362 Age 16.25-16.75	Grade 1: no acne or insignificant lesions 21%						Grade 2: <u>mild</u> acne – a few comedones/papules/pustules 59%					Grade 3: <u>moderate</u> acne – prominent lesions 14%	Grade 4: <u>severe</u> acne with inflammatory lesions and possibly cysts 0.8%

Table 3 Summary of prevalence information

	Population estimates	Source
Lifetime incidence of acne in the general population	99%	2; 3; 5; 6
Lifetime incidence of at least moderate acne	1%	6
Percentage of people with minimal/mild acne who scar	Unknown but probably small and mild scarring	_
Percentage of people with moderate/severe acne who scar	80%	33; 34
Percentage of acne scarred people with moderate-severe scarring	Unknown but scarring severity increases with original acne severity. Estimate 30%	_
Percentage of acne scarred people with mild scarring	Estimate 70%	
Percentage of acne scarred people sufficiently psychologically affected to require treatment	Minimum 1%	West Midlands Survey (see text)

group) have had moderate acne and been left with residual scarring. If one in seven acne scarred people were "severely disfigured"[3], in the West Midlands this might be 106 per year (1/7 *x* 22,092 ÷ 30). It is not clear how many of these will be sufficiently distressed to require treatment, but the patients who do request treatment are not necessarily severely scarred (Stewart, G. Personal communication). Many are distressed by an apparently small degree of scarring. A minimum of about 175 requests per year is indicated from a survey of West Midlands dermatologists (see below).

Summary

- The prevalence of people with acne scars in the population is uncertain although it is probably about 1%
- Psychological factors and severity will influence demand for treatment – the effects of both of these variables are uncertain and will require modelling
- Historically, lack of effective treatment has resulted in some unexpressed need, but the amount of this is uncertain

2.4 Current Service

It is not possible to estimate the number of GP consultations for acne or acne scarring because routine GP morbidity statistics[38] are not sufficiently detailed. Similarly, Hospital Episode Statistics (HES) data were also of little use. HES data for the West Midlands (1996-97) revealed only one inpatient episode for laser treatment of unspecified acne disorder, one day-case episode for dermabrasion of unspecified acne disorder and one inpatient episode for dermabrasion of an acne keloid. There may be several reasons for this apparent low rate. Resurfacing treatment may be carried out as an outpatient procedure (not covered by HES), it may also be misclassified, and laser resurfacing may be carried out privately as an Extra Contractual Referral (ECR).

A questionnaire of service provision for acne patients was sent to all 32 dermatologists in the West Midlands (Appendix 1) with a 90% response rate. Table 4 details the responses.

Table 4 Results of dermatologists' questionnaire of service provision in the West Midlands NHS

Total number of dermatologists in the West Midlands		32
Questionnaire response rate		29/32 (91%)
Number of eligible dermatologists*		27
Approximate number of patients seen about acne scars per year		> 310
Approximate number of patients treated or referred for treatment per year†		>105
Approximate future need for treatment per year (number of patients)		> 175
Number of dermatologists treating/referring patients for (per year): §		
Laser	Carbon dioxide	8
	Erbium:YAG	1
	Not specified	6
Dermabrasion		6
Chemical peel		2
Decision of plastic surgeon		2
Other		3
No treatment		4
Not stated		2
Numbers of dermatologists treating/referring patients (per year) who:		
Have any severity of scar		5
Only have severe scarring		5
Are both severely scarred and psychologically affected		4
Are severely psychologically affected regardless of scar severity		4
Either have severe scarring or are severely psychologically affected		5

* 1 dermatologist's NHS practice was in skin oncology only, 1 dermatologist sees children only
† only 2 dermatologists carried out their own treatment
§ 6 dermatologists referred for more than one type of treatment

Approximately 310 patients per year are referred to 27 dermatologists about their acne scars; about 105 of these are treated or referred for treatment. 8 dermatologists referred their patients for carbon dioxide laser, 1 for Er:YAG laser and 6 for unspecified laser treatment. 8 dermatologists still referred patients for dermabrasion or chemical peel, and 2 did not refer their patients at all. The West Midlands Guidelines for Purchasing Aesthetic Surgery do not include laser resurfacing for the treatment of acne scars, and this is the reason cited by 5 dermatologists for either not treating at all or not referring patients for laser therapy.

Dermatologists in the West Midlands estimate that if a treatment were to be found effective, there might be future referrals of at least 175 patients per year.

Summary of current service

- Resurfacing treatment options include chemical peel, dermabrasion and laser resurfacing
- Laser treatment is preferred because it is more precise, less operator dependent, has fewer operational problems and a better side effect profile
- Laser resurfacing for the improvement of acne scars is usually carried out in private practice
- At least 175 patients per year in the West Midlands could benefit from an effective resurfacing procedure

3. Question addressed by this review

The effectiveness and cost-utility of laser resurfacing in the improvement of atrophic and "ice-pick" facial acne scarring was compared with no treatment.

4. Methods

4.1 Search Strategy for identification of studies

Reviews and primary studies were identified by:

- Search of MEDLINE (1966 – April 1998) and EMBASE (1988 – March 1998) electronic databases using the MeSH headings "acne vulgaris" "cicatrix" "lasers" "laser surgery" and the textwords "acne" "cicatrix" "scar$" "laser$" " carbon dioxide laser$" "Erbium YAG laser$"
- Search of the Science Citation Index (-March 1998) using the search terms as above
- Search of the Cochrane database, York database (CRD, DARE), INAHTA, NHS HTA internet site, Bandolier, Effectiveness Matters, Effective Healthcare
- Search of the NEED database and Internet sites of UK health economics units
- Personal contact with dermatologists and plastic surgeons
- Citations from reference lists

4.2 Criteria for including studies

4.2.1 Study design

Primary studies of all types were included. It was likely that the relevant studies would be case-series rather than randomised controlled trials. Relatively good quality evidence potentially could be obtained for this condition from observational series with blinded before and after comparisons, as well as from randomised controlled trials, or from studies with control areas matched to treatment areas (within patients).

4.2.2 Study population

The studies should include some patients treated for atrophic or ice-pick acne scars. Treatments for hypertrophic acne scars or keloid scars or rhinophyma (a condition arising from acne rosacea) were not considered.

4.2.3 Types of intervention

1. Carbon dioxide laser resurfacing
2. Erbium:YAG laser resurfacing
3. Other lasers

4.2.4 Outcome measures

Studies would be excluded if there were no details of either primary outcomes of scar improvements or side effects. The quality of any outcome measures would be evaluated. The ideal outcome measures for scar improvements would be:

(a) optical profilometry of the skin before and after treatment using silicon impressions and analysed digitally, and

(b) patient satisfaction and psychological status, measured by standard quality of life or psychological questionnaires before and after treatment.

Less reliable measures would be visual impression of scar improvement by the clinician.

4.3 Methods of the review

4.3.1 Data extraction

Data was extracted by two researchers independently and differences discussed.

4.3.2 Appraisal of studies: points for assessing quality

The following criteria were used in the assessment of case series:

(i) Were the data collected prospectively or retrospectively and could this be assessed?

(ii) How were the patients selected and how representative is the sample with regard to the population of acne scarred patients requiring treatment? Was the selection of patients described?

(iii) How well were the patients described?

(iv) How was any improvement assessed?

(v) Who were the observers and were the observers blind?

(vi) Were the baseline data, outcome data, follow-up and loss to follow-up reported in full? Were all patients accounted for in the analysis?

4.3.3 Synthesis of effectiveness data

Effectiveness estimates and details of side-effects were summarised as a range from all studies. Point estimates were taken from the middle of the range of the best quality studies. Utility values for quality of life were modelled (using the IHQL and the EQ-5D scales) as there was no data available.

4.3.4 Type of economic evaluation

Cost utility analysis and sensitivity analysis were modelled. Costs were obtained from private healthcare price lists.

5. Quality, direction and strength of the evidence

There are no controlled trials of laser resurfacing to improve acne scars; however, 16 case series were identified which included patients with atrophic or ice-pick facial acne scarring undergoing laser resurfacing. The carbon dioxide laser was used in 13[24-32; 39-42], and the Erbium:YAG laser in the other three[22; 43; 44]. 2 studies were excluded as they did not report any outcomes[40; 42]. Tables 5 and 6 summarise the quality of each included case series for a range of assessment points. All of the studies were of poor quality and 11 out of the 14 included studies included less than 15 relevant patients. 3 were prospective[31; 32; 41], but the remainder were likely to be retrospective or could not be determined. In no case was there a clear description of the study design. The types and severity of scarring were not well described; there were no standard scales to describe either variable.

Valid and reliable measures of improvement in scarring would be:

(a) optical profilometry of the skin before and after treatment using silicon impressions and analysed digitally, and
(b) Patient satisfaction and psychological status, measured by standard quality of life or psychological questionnaires before and after treatment.

No studies measured the psychological status of the patients either before or after treatment; one study reported the results of optical profilometry in a subset of patients[32] but the remainder measured improvement clinically, usually by non-blinded observers. Most of these studies had taken photographs at baseline and at outcome[22; 24-27; 29; 30; 32; 39; 41; 43], although this is not generally held to be very accurate or reproducible (Waters, R. Personal communication). The scale for quantifying visual improvement varied widely and was usually based on subjective percentage improvement; the final visual result of which would depend entirely on initial severity. Mean improvements were all calculated from ordinal scales, but medians rather than means should have been reported as measurements were likely to be skewed. The properties of these scales are not known; points on an ordinal scale are not necessarily equidistant. The scales varied from study to study and no scale had had its validity or reliability investigated. Reported means from these studies reflect the range and number of categories available, and results cannot be compared across studies.

Follow-up (for individual patients) ranged from 2 weeks to 23 months, frequently with no indication of the completeness of follow-up or reasons for any loss to follow-up. It is likely that in most cases the follow-up would be too short to examine the eventual effects of resurfacing. Although the erythema subsides on average after 2 months, there is often a slight residual swelling, which may last longer and which artificially enhances the appearance of the skin [personal communication – Ruth Waters]. Any improvement recorded before the residual swelling subsides might overestimate the final effect.

5.1 Carbon dioxide laser resurfacing

There are 11 case series reported which include patients treated for acne scars.

The largest study[25] was a series of 50 patients with acne scars. Although poor quality, it was better than the other ten. The improvement in scarring (although assessed using photographs) was assessed blindly and was given for a range of skin types (I (lightest)-V (darkest)[45]. Patients had moderate-severe scarring (no definitions given) and a mean overall improvement

Table 5 Quality checklist : acne scars treated with the carbon dioxide laser: case-series

	Alster 1996[25]	Apfelberg 1997 (1)[27]	Apfelberg 1997 (2)[26]	Apfelberg 1996[28]	Bernstein 1998[29]	Bernstein 1997[24]	David 1995[39]	Ho 1995[30]	Rubach 1997[31]	Ruiz-Esparza 1998[41]	Shim 1998[32]
General criteria											
Is it a prospective study?	NS	no	no	NS	no	no	NS	NS	yes	yes	yes
Are the subjects' demographic details clearly described?	yes	yes	yes	yes	yes	yes (whole series)	yes (whole series)	no	no	no	yes
How many relevant subjects?	50	13	5	<11	3	NS	6	13	<14	<36	<12
Patient Characteristics											
Is this the subjects' first surgical treatment for scarring?	yes 28 no 22	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Are the types of scars described?	yes (atrophic)	yes	no	no	no	no	no	no	no	no	no
Is the severity of scarring specified?	yes	yes	no	no	no	no	no	no	no	no	no
Are appropriate exclusion criteria stated?	yes	no	yes	yes	no	no	no	yes	yes	no	yes
Intervention											
Is the intervention clearly described?	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Outcomes											
Is the outcome assessed by independent blind observers?	yes	no	NS	NS	NS	NS	NS	no	NS	No	NS
Is the outcome measured clinically?	yes	yes	yes	no	yes	yes	yes	yes	no	yes	yes
Is the outcome measured digitally?	no	no	no	no	no	no	no	no	no	no	yes
Are the outcomes quantified?	yes	yes	yes	no	yes	no	no	yes	no	yes	yes
Are there psychological measures?	no	no	no	no	no	no	no	no	no	no	no
Are the side effects recorded and detailed?	yes	yes	yes	yes	yes	yes	yes	yes	whole group only	yes	yes
Is the follow-up sufficient?	no (6 mths)	no (7 mths)	no (2-9 mths)	NS	no (2 mths)	no (>4 mths)	no (max 3 mths)	no (3 mths)	no (6 mths)	no (6 mths)	no (mean 3.5 mths)
Are there losses to follow-up?	no	yes	NS	NS	NS	NS	NS	NS	NS	yes	NS
Are the reasons given for losses to follow-up?		no								no	

NS = Not Stated

Table 6 Quality checklist : acne scars treated with the Erbium:YAG laser: case-series

	Drnovsek-Olup 1997[43]	Kye 1997[22]	Weinstein 1998[44]
General criteria			
Is it a prospective study?	NS	NS	NS
Are the subjects' demographic details clearly described?	no	yes	no
How many relevant subjects?	2	21	10
Patient Characteristics			
Is this the subjects' first surgical treatment for scarring?	NS	NS	NS
Are the types of scars described?	no	no	no
Is the severity of scarring specified?	no	no	no
Are appropriate exclusion criteria stated?	no	no	no
Intervention			
Is the intervention clearly described?	yes	yes	yes
Outcomes			
Is the outcome assessed by independent blind observers?	NS	yes	NS
Is the outcome measured clinically?	yes	yes	yes
Is the outcome measured digitally?	no	no	no
Are the outcomes quantified?	yes	yes	yes
Are there psychological measures?	no	no	no
Are the side effects recorded and detailed?	no	yes	no
Is the follow-up sufficient?	no (5-11 mths)	no (3 mths)	no (3-12 mths)
Are there losses to follow-up?	NS	NS	NS
Are the reasons given for losses to follow-up?			

NS = Not Stated

(based on an ordinal scale) of 81.4% (range 70-90%), although this was larger than most other studies (25-75%). 36% of patients did have transient hyperpigmentation, although this resolved in 3 months. 14% of patients developed milia, but there were no bacterial or viral infections. Topical antibiotic had been given post-operatively in all patients, and acyclovir in patients susceptible to *herpes simplex* infections.

Table 7 summarises the details of each study. Only 3 studies described only patients being treated for acne scars[25; 26]; the remainder included patients with other types of scars or patients having the resurfacing treatment for the improvement of wrinkles, some of which gave separate details for acne scarred patients. Two of the studies included patients only of Hispanic[41] or Asian[30] origin as they were concerned with investigating the effect of resurfacing darker skin types. The ages of patients being treated for acne scars ranged from 21-69 (where given). In 5 studies that specified the sex of patients, more women were treated than men. Several studies excluded patients who had taken isotretinoin as an acne treatment in the last 6mths – 2 years[25; 27; 28; 30-32], because it is thought that this treatment alters the follicles and impairs regeneration of the skin after resurfacing, thereby increasing the risk of scarring[16; 19].

Table 7 CO2 laser treatment of acne scars : summary of included case series

* Based on the Fitzpatrick skin types, where I is the fairest skin and VI the darkest[45]
† it is not clear whether there are common patients in these series
§ Full details (where available) given only for acne scarred patients
NS = not stated

Study	Subjects n (M/F) §	Type of acne scar	Skin type*	Intervention & extent	Measure of improvement	Follow up	Scar improvement
Alster 1996[25]	50 (6/44) mean age 40.2 (21-69) Excluded patients with isotretinoin use within 2 yrs	Atrophic Moderate-severe	I (5) II (29) III (12) IV (3) V (1)	High energy pulsed, handpiece Energy density: 7 J/cm^2 Passes: 3-6 Extent: both cheeks	Photographs before and after Blind assessment of photographs % improvement relative to normal surrounding skin (in gradations of 10%)	1,4,8,12,24 wks. Mean follow up not stated, but at least 6 months	Mean 81.4% (70-90)
Apfelberg (1) 1997[27] †	13 (2/11) mean age 38.4 (23-47) No exclusions stated	Atrophic Mild 8 Severe 5	NS	Ultrapulse CPG Energy density: 7.5 J/ cm^2 Passes: 2-4 Extent: Full face (9) regional (4)	Some photographs were taken Not blind assessment Fair/good/excellent Fair = minor change/improvement Good = good correction Excellent = marked/complete correction	Mean 7.18 mths No range given 1 patient lost – no reason given	Mild – Excellent (7) Good (1) Severe – Good (2) Fair (2)
Apfelberg (2) 1997[26] †	5 (5/0) out of a series of 11 patients mean age 39.8 (31-46) Excuded patients with isotretinoin use within 12-18mths	NS	NS	Ultrapulse CPG Energy density: 7.5 J/ cm^2 Passes: 3-6 Extent: Not specified, probably full face	Some photographs Assessment method not specified but not blind % improvement	Mean 5.6 mths (2-9)	>75% n=3 >50% n=2
Apfelberg 1996[28] †	Group of 110 patients including 11 with acne or chickenpox scars Mean age 24.6 Excluded patients with use of isotretinoin within 12-18mths. Performed test patches on people with past history of keloid scars.	NS	NS	Ultrapulse with CPG Energy density: 7.5J/ cm^2 Passes: 3-5 Extent not known	No information about measure of improvement given	NS	No outcome reported

Study	Subjects n (M/F)	Type of acne scar	Skin type	Intervention & extent	Measure of improvement	Follow up	Scar improvement
Bernstein 1998[29] †	3 patients with acne scars (as part of a larger group of other scars) Scars were at least 1 yr mature	NS	NS	Ultrapulse with CPG Energy density: 7.5J/ cm^2 or Continuous wave with flashscanner 20W, pulse 0.2secs, 6mm spot; 14J/cm^2 Extent: full or partial face Passes: 3 (2-6)	Photographs were taken before and at follow-up visits 4 independent observers % improvement within a quartile scale	All at least 2 months	50-75% n=2 >75% n=1
Bernstein 1997[24] †	104 women for wrinkles or scars; numbers of each not given.	NS	NS	Ultrapulse with CPG Energy density: 7.5 J/ cm^2 Or Continuous Wave with scanner 16-20W, 0.2 sec scan, 6mm spot; 11-14J/ cm^2 Passes: 1-4 Extent: some full face, some partial	Photographs were taken but no details given No details about observers	Mean 8.2 mths (4-23)	No results Only side effects reported
David 1995[39]	61 patients including 6 with acne scars	NS	NS	Ultrapulse with handpiece (3mm) (1-2 passes) followed by Ultrapulse with CPG Energy density: 7.5 J/ cm^2 1-2 passes Full face or cosmetic unit	Photographs were taken before and after but no information given	2 weeks for all but up to 3 months in some cases	No outcomes reported
Ho 1995[30]	13 (NS) age not given Asians and Hispanics Excluded patients with isotretinoin use within 1 yr and after test spots patients with tendency to scarring or pigmentary changes	NS	III & IV	Ultrapulse (n=10), handpiece Energy density: 6.4J/ cm^2 Flashscanner (n=3) 7W, 0.2sec pulse, 4mm spot; 11J/ cm^2 Passes: 2-5	Some photographs Not blind assessment % improvement (within a scale of –1 to +3) -1 = worsening of scars 0 = no effect +1 = 25% improvement +2 = 50% improvement +3 = 75% improvement	All 1wk, 1 mth, 3 mths	"About 25% on average" Further details not given.

Study	Subjects n (M/F)	Type of acne scar	Skin type	Intervention & extent	Measure of improvement	Follow up	Scar improvement
Rubach 1997[31]	14 patients with acne scars or post traumatic scars, out of a group of 74 which included wrinkles No details about age/sex. Excluded patients with use of isotretinoin within 6 mths.	NS	I-III	Ultrapulse with CPG Energy: 200-300mJ Size: variable Energy density variable Passes: 1-3 Extent: NS	No clinical details given	Mean 6 mths (range not given)	No results Only side effects reported
Ruiz-Esparza 1998[41]	Group of 36 (4/32) Hispanic patients including an unknown number treated for acne scars	NS	II-V	Ultrapulse with CPG Energy density: 6.3-7.5J/ cm^2 Passes: 4-7	Photographs % improvement graded by patient	Mean 6 mths	Improvement not given for acne scars but for whole group: 80-100% n=27 60-80% n=5 50% or less n=3 no opinion n=1
Shim 1998[32]	12 (4/8) patients with different types of scars; numbers for acne scars not given Excluded patients with use of isotretinoin within 2 years	NS	NS	Flashscanner 6-8W, 4mm spot or 16-18W, 6mm spot Passes: 1-3	Photographs (12) and textural analysis (6) Blinding not specified % improvement – scale not clarified	Mean 3.3 mths, no range given	53% visual improvement At 12 wks 44.1% textural improvement

Table 7 cont……

Study	Side effects	Pre-operative/operative treatments	Post-operative treatments
Alster 1996[25]	Erythema lasted 2 mths on average (range 1.5-3 mths) 18/50 had transient hyperpigmentation lasting 3 months; 7/50 had milia.	Regional nerve block	Topical antibiotic Acetominophen for 24-48h to reduce swelling and discomfort Acyclovir for 1 week in patients susc. to herpes simplex Sunscreen after 7-10 days Bleaching agent in patients tending to hyperpigment
Apfelberg (1) 1997[27] †	Reepithelialisation 7.3 days Erythema lasted 7.6 wks on av. 2/12 had transient hyperpigmentation lasting 4-6 wks; 1 had Toxic Shock Syndrome requiring intensive care; 2 had repeat treatments	Tretinoin for 3 weeks	Antibiotics (6/13) Antiviral (7/13) in patients susceptible to herpes simplex Moisturisers up to 10 weeks Sunscreen up to 10 weeks
Apfelberg (2) 1997[26] †	Reepithelialisation 9.3 days (range 7-12 days) Erythema lasted 8.9 wks on av.(range 5-12 weeks) No scarring, texture or pigmentary changes	Kligman's mixture (tretinoin, bleaching agent, steroid) for 3-6 weeks Local anaesthetic	Antibiotics starting on the day of surgery Antiviral starting on the day of surgery Bleaching agents for patients with darker skin complexion Moisturisers

Study	Side effects	Pre-operative treatments	Post-operative treatments
Apfelberg 1996[28] †	Re-epithelialisation in scar patients after 6-8 days Erythema lasted 6-10 weeks for whole group of 160 patients There was no pigmentary change observed.	Kligman's solution – Retinoic acid cream, bleaching agent, steroid cream for 3 weeks Local anaesthetic	Antibiotics and antiviral starting on the day of the operation
Bernstein 1998[29] †	Erythema (for whole group) lasted 7-24 weeks No further scarring or pigmentary changes in the 3 acne patients	Local anaesthetic	Topical antibiotic Non-adherent dressing until re-epithelialisation
Bernstein 1997[24] †	Erythema lasted 3.5 mths on av. (1-8 months) Transient hyperpigmentation 3/104 lasting 1.5 mths; transient or persistent hypopigmentation 17/104; transient milia/acne 87/104; no bacterial or viral infections; candidal infection 1/104; transient pruritis 95/104; temporary hypertrophic scarring 3/104; hypersensitivity for several weeks 5/104	Tretinoin cream and bleaching agent for 2-6 weeks Local anaesthetic and sedation if large area resurfaced	Oral antibiotics and acyclovir for 1 week (beginning 1 day pre-op) Moisturisers after re-epithelialisation Steroid treatment if pruritic Some narcotic analgesics
David 1995[39]	Re-epithelialisation 3-14 days in all patients Infection in 1 patient	NS	NS
Ho 1995[30]	Reepithelialisation 7-10 days Erythema lasted 6 weeks on av. Transient hyper pigmentation was the most common side effect (no numbers given) which started after about 6 weeks and lasted 3-4 mths.	Tretinoin cream, bleaching agent, desonide cream for 2-4 weeks Sunscreen Topical, regional and local anaesthetic	Vigilon dressing Acyclovir for 5 days Oral antibiotics for 7 days Sunscreen after 7-10 days Tretinoin, bleaching agent, desonide cream after 4-6 weeks
Rubach 1997[31]	Reepithelialisation (for whole group) after 7 days on av. Erythema (for whole group) lasted 6 weeks on av. (1-12 wks) Transient hyperpigmentation 1/74; viral infection 1/74. No cases of hypopigmentation or scarring.	All patients had intravenous sedation, local nerve blocks and local infiltration	Acyclovir for 5 days (beginning 1 day pre-op) Occlusive dressing for 48 h Petrolatum ointment until reepithelialisation
Ruiz-Esparza 1998[41]	Reepithelialisation in acne patients after 14 days No details of duration of erythema In the whole group – all patients had post-op burning pain for about 30 min; Hyperpigmentation (9/36) and mild hyperpigmentation (7/36) resolved by 3 mths; milia (2/36); skin irritation (3/36)	Sunscreen, for 2 weeks Bleaching agent for 2 weeks Regional blocks and intravenous sedation for all patients	Sunscreen for 1 year after 1 week post-op Bleaching agent for 6 months Acyclovir for 5 days (beginning 1 day pre-op) in patients susc. to herpes simplex
Shim 1998[32]	Erythema typically lasted 8-12 weeks (max 28 wks) (whole group) Transient hyperpigmentation (whole group) n=2. No cases of infection, scarring or hypopigmentation.	Tretinoin cream or glycolic acid lotion for 2 weeks Bleaching agent for 2 weeks in patients with history of hyperpigmentation or skin types III-IV Nerve blocks and/or local infiltration and/or topical anaesthetic	Oral antibiotics and acyclovir until re-epithelialisation (beginning 1 day pre-op) Bleaching agent after re-epithelialisation in patients with history of hyperpigmentation or skin types III-IV Variety of wound-care regimes

Skin type, scar type and scar severity were not well described in the 9 general studies. In the 3 series describing purely acne-scarred patients, scars were atrophic and ranged from mild to severe. No standard scale was used.

Patients may have had either partial or full-face resurfacing, with either the Ultrapulsed carbon dioxide laser (controlled by handpiece or computer pattern generator) or the Continuous Wave laser with flashscanner, or with both. Power and energy settings and spot size varied between studies and sometimes within studies, as did number of treatment passes. Topical, local and regional anaesthesia were all used, as were oral and intravenous sedation.

Other pre-operative and post-operative treatments varied; use of oral antibiotics, antiviral preparations, tretinoin cream to reduce pore occlusion and sunscreen was widespread. Bleaching agents could be used either prophylactically in all patients or those with darker skin types, or post-operatively if signs of pigmentary changes occurred. Post-operative dressings also varied.

Follow-up ranged from 2 weeks to 23 months but was usually less than 8 months.

Mean clinical scar improvement ranged from 25%[30] to 90%[25] where quantified (see table 7). One study indicated that the prognosis for mild scarring was better than for severe scarring[26] – no other study quantified the effects with severity of scarring. Improvement was not graded by scar type. The measures used to evaluate clinical scar improvement were both subjective and based on a variety of ordinal scales. Results quantified by clinicians may not reflect patient perception[46]. Case series are also subject to bias and will tend to overestimate the effects. This is reflected in the uncertainty of the estimates and the unexpectedly high values of improvement seen in several studies[25; 27; 29]. The smallest improvements were seen in the group of Asian patients[30] with darker skins.

Re-epithelialisation was complete after 7-10 days where reported. Erythema lasted about 2 months on average. Most studies detailed the presence or absence of other side effects: Hyperpigmentation was quite common (in up to 45% of patients), as was hypopigmentation, although both were usually transient (lasting for a few weeks only). Details of skin-type in these patients were frequently absent. Bacterial, viral and fungal infections were rare and disappeared on treatment, as were cases of scarring resulting from resurfacing. One case of toxic shock syndrome following *Staphylococcal* infection and necessitating intensive care unit admission was reported.

5.2 Resurfacing using the Erbium:YAG laser

3 case series were identified. Table 8 summarises the details.

The evidence of the effectiveness of the Erbium:YAG laser in the treatment of acne scarring is sparse and poor. The largest case series[22] (only 21 patients) suggests that the median visual improvement might be about 50%. There is minimal evidence for the duration of erythema, and extent of side effects.

The first study[22] was a series of 21 patients (skin type III and IV only) with atrophic (or pitted) acne scars, the second[44] was a series of 141 patients, 10 who were treated for acne scars (skin type not stated). The third[43] included 2 acne-scarred patients out of a group of 64 patients with benign skin conditions. The severity of scarring was not described in any of the studies and no exclusion criteria were given. In one of the studies[44], the Erbium:YAG laser

Table 8 Erbium:YAG laser treatment of acne scars : summary of included case series

Study	Subjects n (M/F)	Type of acne scar	Skin type	Intervention & extent	Measure of improvement	Follow up	Scar improvement
Kye 1997[22]	21 (5/16) mean age 20.7 No exclusion criteria stated	pitted	III-IV	Pulsed Energy density: 16 J/cm^2 Pulse frequency: 7-9Hz Depth: to pin-point bleeding Passes: 4-6 Extent NS	Photographs before and after Assessed by patients and 2 blinded assessors % improvement based on scale: -10 = 100% worsening -5 = 50% worsening 0 = no improvement 5 = 50% improvement 10 = 100% improvement	All 3 months	≤ 25% n=1 25-50% n=10 50-75% n=8 ≥ 75% n=2
Weinstein 1998[44]	10 acne scarring patients out of a group of 141 Age of acne patients not stated No exclusion criteria stated	Not stated	I-VI (whole group)	1. Single spot, Energy density: 8J/ cm^2 Frequency: 8Hz Passes: 2-5 followed by Erbium scanner Energy density: 15J/ cm^2 Frequency: 20Hz, Passes: 2-3 2. For deeper scars, CO2 flashscanner laser was used first Energy density: 30-40 J/ cm^2 Frequency: 125 Hz followed by scanning Er:YAG as above.	Measure not specified. Assessed by patients and 2 other nurses. % improvement where Excellent = >90% Good = 70-90% Fair = 50-70% Poor = <50%	3-12 months	70-90% n=7 50-70% n=3
Drnovsek-Olup 1997[43]	2 acne-scarred patients out of a group of 64 Age of acne patients not stated No exclusion criteria stated	Not stated	Not stated	Pulsed Energy density: 0.5-1.5J/ cm^2 Passes: 1-3 Sessions: 1-2 Extent NS	Photographs before and after. No details about assessors. % improvement.	5-11 months	30%

Study	Side effects	Pre-operative treatments	Post-operative treatments
Kye 1997	Erythema had disappeared by 3 months. Minimal hyperpigmentation (2/21)	Tretinoin cream for 2-4 weeks	Topical antibiotics for 7 days Oral antibiotics and oral steroids for 3-5 days Oral acyclovir for 5 days Bleaching agent, tretinoin and steroid cream after 2 weeks for 2-4 weeks
Weinstein 1998	Re-epithelialisation (whole group) 5-10 days (longer times in those with acne scars) Erythema (whole group) lasted mean 3.6 weeks Transient hyperpigmentation occurred in 11/141 – no details for acne patients. 25/141 had acne as a result of the treatment. A couple of infections and one case of hypertrophic scarring seen in the whole group – no data specifically for acne patients.		Moisturizer after re-epithelialisation Sunscreen Bleaching agent (Skin typeIV) for 4-6 weeks Bleaching agent, alternating with tretinoin (skin type V,VI) for 4-6 weeks
Drnovsek-Olup 1997	Re-epithelialisation (whole group) 7-10 days Erythema lasted up to 2 months in acne patients No scarring was seen.	none	Topical corticosteroid and topical antibiotic for 5-7 days

was used in combination with the carbon dioxide laser for the deeper scars. The interventions were clearly described, but different in all three studies.

Improvement was based on percentage visual improvement which ranged from 25%[22] to 90%[44] (based on ordinal scales). The bias of case series means that it is likely that any improvements are overestimated. Subjectivity and variability of different scales wouldproduce the wide range of effects. There were no optical profilometry measurements or psychological assessments in any of the studies. Follow up was from 3 to 12 months.

Re-epithelialisation occurred in about 10 days, and erythema lasted for 1-3 months. Occasional transient hyperpigmentation was observed, but infection was rare.

Summary of effectiveness

- The quality of studies for both types of laser is poor, and for the Erbium:YAG laser, very sparse
- The results indicate that laser resurfacing might be effective to some extent, but the absence of any controlled studies suggests that reported outcomes are inflated by bias
- There is no good information on the most relevant outcomes, particularly the effect of scar improvement on quality of life

5.3 Benefits and disbenefits

Table 9 shows the benefits and adverse consequences derived from the studies of effectiveness, to be used as the basis for the economic analysis. Due to the lack of good quality data, the range for possible benefits is large, and will be allowed for later in the sensitivity analyses.

6. Economic analysis

6.1 Economic evidence

There was no economic evidence unearthed.

6.2 Quality of life measures

None of the case-series measured any effects of acne scarring or the effects of subsequent resurfacing treatment on psychological status or quality of life. This has not been well documented in the past even for active acne, although several new questionnaires have been developed to assess this in the last five years[10; 47-51]. Some of these have been developed for clinical practice[10; 49; 50]; others for use in clinical trials and research studies[52; 53]. In general, although clinical acne severity was correlated with increasing psychosocial disability[49-51; 54], the clinical severity (measured by the clinician) underestimated the severity perceived by the patient and the distress they felt[46; 50]. Quality of life measures for active acne do not necessarily apply to acne scars. There is a study in progress in Leeds that will determine the

quality of life of people with acne scars by the use of a standard questionnaire (Seukeran, D. Personal communication).

Table 9 Summary of baseline effectiveness information used

Effectiveness of laser resurfacing	**CO2 laser**		**Source**	**Er:YAG laser**		**Source**
	Range (of study means)	*Estimate used*		*Range*	*Estimate used*	
Mean improvement in scarring with carbon dioxide laser	25-81%	50%	[25; 26; 29; 30; 32]	50-70%	50%	[22; 43; 44]
Time to re-epithelialisation	7-14 days	10 days	[26-28; 30; 31; 39; 41]	7-10 days	10 days	[43; 44]
Length of erythema	6-16 weeks	2 months	[25-28; 30-32]	1-3 months	2 months	[22; 43; 44]
Proportion of patients with pigmentary changes	0-44%	35%	[25]	0-9%	10%	[22; 44]
Duration of pigmentary changes	1-6 months	3 months	[25]	2.3 weeks	2.5 weeks	[22; 44]
Recurrence of acne/milia	0-84%	14%	[25]	0-18%	Assume 14%*	*
Duration of acne/milia	3 weeks	3 weeks	[24]	NS	Assume 3 weeks*	*
Proportion of patients with other side effects (scarring, bacterial/viral/fungal infection, hypersensitivity)	0-9%	5 %	[24; 27; 31; 32; 39; 41]	0-2%	Assume 5%*	*
Duration of other side effects	brief	Assume 1 week	[24]	brief	Assume 1 week*	*

*insufficient evidence from Er:YAG series; assume similar to carbon dioxide laser series

A single utility estimate for the reduced quality of life of patients with acne scars was generated for this review. There are no known measurements of quality of life in acne scarred patients, but in the absence of such measurements, a range of values was estimated from both the IHQL and the EQ-5D generic indices of quality of life.

The IHQL measure is three dimensional with a range of values over 5 levels for Emotional distress (E), physical Disability (D) and Pain (P) (see appendix 2). Acne scar sufferers might have a slight social disability (although no further physical disability) but their emotional distress is likely to be predominate. From the IHQL table (appendix 2) the range of valuations (on a scale of 0-1) is probably 0.632 (actively suicidal[55] and slight physical/social disability) to 0.970 (slight distress). A value of 0.781 (E4/D2 – severe distress and slight social disability) was used to describe acne scarred patients severely psychologically affected, and 0.894 (E3/D1 – moderate distress and no physical disability) for acne scarred patients who are moderately psychologically affected.

In a similar way, the EQ-5D index (with 5 dimensions - appendix 3) generates possible values for acne scarred patients from 0.378 (extremely anxious or depressed and having some problems performing usual activities) to 0.848 (moderately anxious or depressed). A value of 0.378 was used to describe patients severely psychologically affected, and 0.848 for patients moderately psychologically affected. Since there are only three possible levels for anxiety/depression, the EQ-5D may not best represent the possibilities for a person with acne scarring. Improvement from being moderately anxious or depressed can only be to “not anxious or depressed”, allowing no intermediary improvement. The IHQL scale has 5 levels,

therefore gives a more sensitive measure of improvement. Table 10 illustrates the utility values assigned to acne scarred patients.

Table 10 Summary of quality of life information used in the economic analysis

Generic quality of life values	IHQL*	EQ-5D*
Mean value attributable to *severe* psychological distress before treatment	0.781	0.378
Value after 50% scar improvement	0.970	0.848
Mean value attributable to *moderate* psychological distress before treatment	0.894	0.848
Value after 50% scar improvement if initially *mildly* scarred	0.970	0.848

*estimated values (see text and appendices 2 and 3)

6.3 Estimating the change in quality of life with treatment

There is no available evidence on the quality of life of acne scarred people after treatment. In order to estimate baseline and changes in the quality of life, a number of assumptions were made:

1. Psychological status is the most important measure of the acne-scarred patient's quality of life. Visual severity (as perceived by the clinician) does not necessarily predict psychological status.

2. Of all acne-scarred patients, 25% are not psychologically affected at all. Of the remainng 75% of patients who are psychologically affected, 1 in 3 (i.e. 25% overall) are severely psychologically affected, and 2 in 3 (i.e. 50% overall) are moderately psychologically affected.

3. Scar improvement after both carbon dioxide laser and Erbium:YAG laser therapy is 50%. Someone who is severely distressed might be more satisfied with a 50% improvement than someone moderately distressed. There may be variation in quality of life improvement within each psychological grouping according to clinical scar severity. However, this cannot be quantified, so for the purpose of this analysis, psychological groupings are not further sub-divided by clinical scar severity. Table 10 summarises the quality of life information used (for both the IHQL and EuroQol indices), and table 11 illustrates the possible improvement associated with 50% scar improvement, by severity of scarring and psychological status (using the IHQL index).

4. Without laser treatment, acne scars do not improve.

5. Side effects of the laser treatment (including erythema, changes in pigmentation, bacterial or viral infection) will affect quality of life, usually for a short time period immediately after laser therapy. Table 12 shows the assumptions made to quantify these. Owing to the short time period, these disbenefits have little effect on the overall quality of life improvement in the long term, although they may have a larger role in patient decisions.

6. Improvement in the acne scars following laser resurfacing, although producing a reduced quality of life for 2 months during convalescence, will ultimately improve the quality of the remainder of the patient's life. Acne scars are likely to be treated after the acne is no longer active, at the earliest, age 25. However, it is likely that the benefits of improving the scarring will reduce over time – the effect of ageing on the face might eventually overcome any visual deformity produced by acne scarring. Patients are also likely to adjust psychologically with time to their facial disfigurement. This is partially accounted for by restricting the benefit to age 65 (i.e. for 40 years) rather than a full lifetime.

Table 11 Calculating the utility values before and after treatment: using the IHQL index

		Utility scores				
		Before		*after*		*change*
Psychologically affected	Severe 33.3%	E4/D2 0.781	→	E3/E1 0.970	=	0.189
	Moderate 66.6%	E3/D1 0.894	→	E2/D1 0.970	=	0.076
Average values		**0.859**	→	**0.973**	=	**0.114**

Figure 1 is a probability tree which shows scarred patients divided by possible emotional distress levels with appropriate probabilities. Each pathway also includes treatment related benefits, disbenefits and side effects, given in terms of proportion of patients affected, average length of time affected for and quality of life adjustment during that time.

The overall benefit of laser therapy is expressed as gain of quality adjusted life years (QALYs). This takes into account any additional years of life gained by having the treatment (in the case of acne scars this is probably zero) and also the quality of life gained during the following years (the overriding effect in this case). The overall quality of life gained (in QALYs) in this case is the average yearly utility increase after treatment from baseline (assuming any untreated groups would not experience change in quality of life) multiplied by the 40 years, MINUS the average utility decrease due to the side effects of treatment. (The utility gained due to treatment is weighted by the proportions in each scar severity/psychological status group, and the side effect utility scores are weighted by the proportions expected to experience each individual side effect and the duration – see tables 9 and 12).

Figure 1 Probability tree to show outcomes of acne scarred patients undergoing laser resurfacing

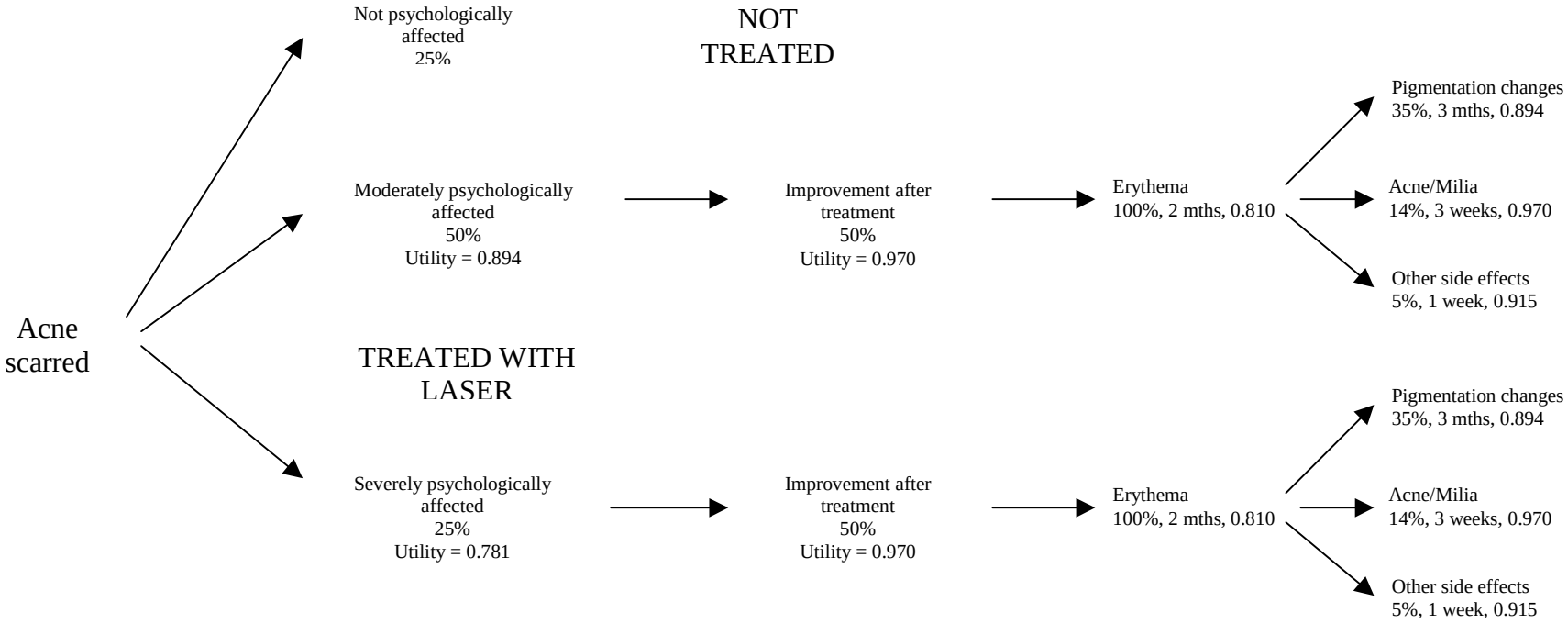

Table 12 Utility values for treatment associated side-effects

						Carbon dioxide laser			Erbium:YAG lsaer	
Index	**Treatment-associated effects**	**Possible Health state***	**Utility score**	**Utility reduction**		**Duration of effect†**	**QALY reduction (utility reduction x time in years)**		**Duration of effect**	**QALY reduction (utility reduction x time in years)**
IHQL index	Erythema	D3/P2/E3	0.810	0.19		2 mths	0.032		2 mths	0.032
	Pigmentary changes	D1/P1/E3	0.894	0.106		3 mths	0.027		2.5 wks	0.005
	Acne/milia	D1/P1/E2	0.970	0.03		3 wks	0.002		3 weeks	0.002
	Other (incl. scarring, bacterial/viral/fungal infections, hypersensitivity)	D1/P2/E2	0.915	0.085		1 wk	0.002		1 wk	0.002
EQ-5D index	Erythema	12213	0.274	0.726		2 mths	0.121		2 mths	0.121
	Pigmentary changes	11112	0.848	0.152		3 mths	0.038		2.5 wks	0.007
	Acne/milia	11112	0.848	0.152		3 wks	0.009		3 weeks	0.009
	Other (incl. scarring, bacterial/viral/fungal infections, hypersensitivity)	11112	0.848	0.152		1 wk	0.003		1 wk	0.003

* For definition of health states see appendices 2 and 3 † For sources see table 9

Taking into account all the assumptions above, carbon dioxide laser resurfacing might result in a gain of 4.5 QALYs (using the IHQL) or 6.1 QALYs (using the EQ-5D) per person treated. Similarly, for the Er:YAG laser, a 50% improvement might also provide a gain of 4.5 and 6.1 QALYs using the IHQL and EQ-5D respectively.

6.4 Cost-utility analysis

Table 13 gives the costs for the resurfacing treatments. The following assumptions are made: Patients have only 1 operative consultation.

1. Each treatment requires 3 other consultations (once pre-operatively, twice post-operatively).

2. 5% of patients require a test area (if they have darker skin or are susceptible to pigmentary changes or keloid scarring).

3. 50% of patients have a full-face procedure, the remainder have an average of 2 cosmetic units resurfaced.

4. 5% of patients undergoing carbon dioxide laser resurfacing require a general anaesthetic but none of the patients undergoing Er:YAG laser resurfacing require one.

5. 50% of patients are prescribed Retin-A cream; 50% of patients are prescribed antibiotics for an average of 1 week; 1% of patients require anti-viral treatment for 5 days; no patients are prescribed bleaching agent.

Using these assumptions and the costs given in table 13, the average total cost for resurfacing using the carbon dioxide laser is £3267 and using the Erbium:YAG laser is £3252. The total cost of both treatments is much the same. Using these costs, the base estimates of effectiveness in tables 9 and 10 and the gain in QALYs calculated in the previous section, the cost of carbon dioxide laser resurfacing treatment is £726 per QALY (IHQL scale), and the cost of Er:YAG laser resurfacing is virtually identical, at £721 per QALY (IHQL scale). Using the EQ-5D scale the costs are £534 and £530 per QALY respectively.

Table 14 gives total costs of treatment depending on local population size.

6.5 Discounting

There is no agreement as yet about whether health benefits should be discounted over time, and at what rate they should be discounted. In this case however, the changes in facial appearance with ageing make it probable that the value of the treatment to the patient will decrease over time, and the argument in favour of discounting is strong. In this section the costs per QALY are presented discounted at a rate of 6% per year over 40 years, to give the health benefits (in QALYs) in terms of net present value. Since the financial costs identified in this review are incurred once only at the start of the time period, there is no need to discount them. The discounted costs of carbon dioxide and Erbium:YAG laser resurfacing are therefore £1846 and £1828 per QALY respectively (using the IHQL scale) and £1387 and £1373 per QALY using the EQ-5D scale.

Table 13 Cost estimates for the resurfacing treatment of acne scarring

			Carbon dioxide laser	Er:YAG laser
Costs per resurfacing treatment*				
Item	***Unit cost***	***Requirement***	***Mean number of units***	
Consultation	£95	All patients	3	3
Extent of resurfacing				
Test area	£315	5% of patients	0.05	0.05
1 unit	£1260			
2 units	£2100	50% of patients have a mean of 2 units	0.5	0.5
3 units	£2940			
Full face	£3780	50% of patients	0.5	0.5
General Anaesthetic	£300	in 5% of patients having carbon dioxide laser	0.05	0
Local Anaesthetic	Included in the price		0.99	1
Retin A cream	£21	All patients	1	1
Bleaching agent			0	0
Antibiotics	£0.70†	In 50%. Tetracyclines or trimethoprim, 1 week	0.5	0.5
Antiviral	£29†	If past history (about 1%), Zovirax or Valtrex, 5 days.	0.01	0.01
Mean number of resurfacing treatments			1	1
Average total cost (full series of treatments) per person			£3267	£3252

* the prices are according to the charges at Lasercare Clinics, 1998, and are identical for both the carbon dioxide and Erbium:YAG lasers
† these costs were obtained from the BNF, March 1998[56]

Table 14 Total costs of laser resurfacing treatment with population size

	No of patients requiring resurfacing	Carbon dioxide laser	Er:YAG laser
Cost per QALY per patient*	1	£726	£721
Total cost per patient	1	£3267	£3252
Total costs with a population of 2000	<1	-	-
Total costs with a population of 250,000	20	£65,300	£65,000

* using the IHQL scale

6.6 Sensitivity analysis

Appendix 4 gives the costs per QALY (undiscounted) for laser resurfacing if the key variables are altered within the potential range. The text in **bold** indicates the base values. The high and low values for each variable are typically wide to reflect the uncertainty of both the effectiveness data and the quality of life modelling. The costs per QALY ranged from £320 to £2180; the lowest value was derived from the best quality of life improvement using the EQ-5D index, and the highest value was produced if each patient required 3 laser resurfacing treatments. The variables which had the greatest impact on cost were:

- The degree to which patients were psychologically affected by their scarring;
- The average age that patients were treated and to what age the benefit of their treatment would be felt (this difference predicts the number of years of improved quality of life);
- The average number of treatments, the extent of facial resurfacing and the cost of the resurfacing procedure;
- The utility values assigned to the acne-scarred patients before and after the resurfacing procedure. The two possible generic indices were the IHQL and the EQ-5D scales. Laser resurfacing was more cost-effective if the EQ-5D scale was used – this reflects the higher weighting given to the anxiety/depression dimension, and also the lack of sensitivity in having only 3 levels per dimension. Any improvement in quality of life results in larger changes on the utility scale.

The uncertainty around the cost-utility values could be improved with more certain estimates of the effectiveness. The costs are not likely to vary as much as the range of values used in the sensitivity analysis – laser resurfacing is carried out privately and would be subject to the normal market competition. The evidence of effectiveness is based on one resurfacing procedure. In practice, if the plastic surgeon is more cautious, more than one resurfacing procedure might be required to produce an acceptable result.

Despite the uncertainties of the data, the laser resurfacing procedure is cheap – even if 3 separate resurfacing procedures were required, the cost is less than £3000 per QALY.

7. Conclusions and further comments

- The quality of the effectiveness data is very poor and required modelling of any changes in quality of life scores. This results in wide potential ranges of effects.
- Poor quality evidence indicates that there is some improvement in acne scarring with laser resurfacing although neither the benefits nor disbenefits can be quantified with certainty.
- There is no good evidence as yet to support the belief that there is a difference in effectiveness between the Erbium:YAG laser and the carbon dioxide laser, or that the severity and duration of post-treatment erythema and side effect profile is any different.

- The cost estimates are probably representative of UK prices but inaccuracies in QALYs will have a major effect on the cost utility estimates. However, it is likely that the cost of laser resurfacing over no treatment is less than £3000 per QALY

- Further primary research in the form of controlled trials (which must include validated quality of life measures) is needed in order to quantify the benefits and disbenefits and to compare the two lasers, ideally:

  Study design
  A randomised controlled trial (either right to left comparison or a parallel group of randomly selected patients).

  Population
  Adults with atrophic or ice-pick acne scars, stratified by severity. A standard scale should be identified and used with baseline psychological or quality of life measurements.

  Intervention
  Carbon dioxide laser *versus* Erbium:YAG laser.

  Blinding
  Observers should be blinded to the initial scar severity and the treatment experienced.

  Outcomes
  Clinical scar improvement measured by optical profilometry; patient satisfaction measured by accepted quality of life scoring system; side effects.

Anticipated expiry date

- **This report was finished in December 1998**
- **The searches were completed in April 1998**
- **There are no trials known to be in progress**
- **The HTA was notified of the lack of evidence for this procedure and laser treatment for acne scars suggested as a topic requiring further primary studies**
- **The conclusions of this report should be re-evaluated when further research evidence becomes available**

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9. Appendices

Appendix 1 Treatment of acne scars within the NHS: Dermatologists' questionnaire

Appendix 2 Index of Health Related Quality of Life

Appendix 3 The EuroQol EQ-5D index

Appendix 4 Sensitivity analysis

Appendix 1

THE UNIVERSITY
OF BIRMINGHAM
Department of Public Health and Epidemiology

TREATMENT OF ACNE SCARS WITHIN THE NHS: DERMATOLOGIST'S QUESTIONNAIRE

Q1. Approximately how many NHS patients are referred to you about acne scarring per year? ☐

Q2. Do you treat any of these patients for acne scarring? ☐

If so,

(a) how many per year approx? ☐

(b) Which treatments:

(i) chemical peel ☐
(ii) dermabrasion ☐
(iii) laser treatment
CO_2 ☐
Other ☐

please specifiy……..

Q3. Do you refer patients for any treatments? ☐

If so,

(a) how many per year approx? ☐

(b) Which treatments:

(i) chemical peel ☐
(ii) dermabrasion ☐
(iii) laser treatment
CO_2 ☐
Other ☐

please specifiy……..

Q4. In general, what type of patients would you treat or refer for treatment?

(a) only those with severe scars ☐
(b) those with all severities of scar ☐
(c) only those severely psychologically affected ☐
(d) only those severely scarred and psychologically affected ☐

Q5. If you do not treat or refer patients for acne scarring, is this because:

(a) there is no clinical need ☐
(b) there is no effective treatment ☐
(c) other ☐
please specifiy…….

Q6. If a new and effective treatment became available, how many patients would you treat/refer for treatment per year (approx)? ☐

NAME…….. **DATE……..**

Thank you for your help – please return this questionnaire in the enclosed reply-paid envelope by April 15th.

Appendix 2 Index of Health Related Quality of Life (Rosser et al)

The IHQL provides a broad and sensitive measure of social, psychological and physical functioning, and is designed to be applicable across all diagnostic groups. Using this instrument, it is possible to derive an assessment of health status on a single unidimensional scale,

The IHQL is derived from the original two-dimensional Rosser Index based on the dimensions of disability and distress. In this scale, distress is separated into physical and emotional components, to give three dimensions (disability, physical distress and emotional distress).

3-Dimensional Classification

Disability

D1: No physical disability; perfectly mobile and physically active; able to perform all self-care and role functions.

D2: Slight social disability, e.g. having a slight cold. No limitations with physical ability, self-care or mobility, but some role functions slightly impaired by social disability

D3: Slight physical disability. Able to get round house and community, but unable to perform heavy physical tasks. Role functions slightly limited by physical disability. Able to perform all self-care activities.

D4: Able to get round house and do lighter physical work. Some difficulty in getting community due to weakness or other physical limitations. Can perform all self-care activities. Ability to perform role functions limited.

D5: Difficulty in getting around house, can only go out with assistance. Major physical limitations, e.g. can only do light work. Can perform most self-care activities, but need help getting in and out of the bath. Limited ability to perform role functions.

D6: Confined to a chair, therefore can only get out with assistance. Can only do the lightest of tasks, e.g. switch on the TV. Can feed self, but needs help with all other health care activities. Very limited ability to perform role functions.

D7: Confined to bed. Needs help with all self-care activities. Minimal ability to perform role functions.

D8: Unconscious

Discomfort (Physical)

P1: No pain
P2: Slight pain: (a) occasionally, (b) frequently. (c) almost all the time
P3: Moderate pain: (a) occasionally, (b) frequently. (c) almost all the time
P4: Severe pain: (a) occasionally, (b) frequently. (c) almost all the time
P5: Agonising pain: (a) occasionally, (b) frequently. (c) almost all the time

Distress (Emotional)

E1: No distress: very happy and relaxed almost all of the time.
E2: Slight distress: happy and relaxed most of the time, but anxious and depressed some of the time.
E3: Moderate distress: anxious and depressed most of the time, but happy and relaxed some of the time.
E4: Severe distress: very anxious and depressed almost all of the time.
E5: Extremely depressed: actively suicidal.

Composite state valuations (0-1 scale of values)

		E1	E2	E3	E4	E5
P1	D1	1,000	0.970	0.894	0.791	0.643
	D2	0.990	0.960	0.884	0.781	0.632
	D3	0.971	0.940	0.864	0.762	0.614
	D4	0.946	0.917	0.840	0.738	0.590
	D5	0.917	0.887	0.811	0.710	0.561
	D6	0.885	0.855	0.780	0.678	0.530
	D7	0.838	0.804	0.729	0.628	0.481
P2	D1	0.944	0.915	0.838	0.736	0.588
	D2	0.934	0.904	0.828	0.726	0.578
	D3	0.915	0.885	0.810	0.708	0.559
	D4	0.891	0.861	0.785	0.684	0.537
	D5	0.861	0.831	0.756	0.654	0.508
	D6	0.829	0.799	0.724	0.623	0.477
	D7	0.779	0.750	0.675	0.574	0.427
P3	D1	0.867	0.837	0.761	0.660	0.513
	D2	0.857	0.827	0.751	0.650	0.503
	D3	0.837	0.808	0.732	0.631	0.485
	D4	0.814	0.784	0.709	0.608	0.461
	D5	0.785	0.755	0.680	0.579	0.433
	D6	0.753	0.723	0.648	0.548	0.402
	D7	0.702	0.674	0.598	0.498	0.353
P4	D1	0.714	0.685	0.610	0.510	0.365
	D2	0.703	0.675	0.599	0.499	0.354
	D3	0.685	0.656	0.581	0.481	0.337
	D4	0.661	0.632	0.557	0.458	0.313
	D5	0.632	0.604	0.528	0.429	0.285
	D6	0.601	0.572	0.497	0.399	0.254
	D7	0.551	0.522	0.449	0.350	0.207
P5	D1	0.468	0.439	0.365	0.267	0.125
	D2	0.457	0.428	0.355	0.257	0.114
	D3	0.439	0.410	0.337	0.239	0.097
	D4	0.416	0.387	0.314	0.216	0.074
	D5	0.387	0.358	0.285	0.188	0.047
	D6	0.356	0.327	0.255	0.159	0.017
	D7	0.308	0.279	0.207	0.111	–0.030

from: Rosser et al, Index of health-related quality of life in Hopkins A, *Measures of the quality of life* 1992, Royal College of Physicians

Appendix 3 The EuroQol EQ-5D Index

What is EQ-5D?

EQ-5D is a measure of health status developed for use in evaluating health and healthcare. It produces a numeric score for health status on which full health has a value of 1 and death has a value of 0. EQ-5D was developed by an international research group (see EuroQol Group below).

EQ-5D describes health status in terms of 5 dimensions

- Mobility
- Self care
- Usual activity
- Pain/discomfort
- Anxiety/depression

Each dimension is divided into 3 levels

- 1 – no problem
- 2 – some problem
- 3 – extreme problem

By combining different levels from each dimension, EQ-5D defines a total of 243 health states.

In the UK, the relative importance of each level/dimension is known from the results of a national survey of the general population commissioned by the Department of Health in 1993.

How is EQ-5D data collected?

A short 3-page questionnaire is completed by patients themselves. The questionnaire takes about a minute to fill in.

The questionnaire records

(a) the level of problems (if any) on each of the 5 dimensions
(b) the patient's rating of their overall health status using a 'thermometer'-like scale, marked 0 – 100
(c) minimal background information on the patient (this can be omitted if it duplicates pre-existing information)

What kind of information does EQ-5D produce?

EQ-5D generates 3 types of data for each patient

(a) a profile, indicating the extent of problems across the 5 dimensions
(b) a weighted health index, based on population values obtained from the 1993 survey
(c) a score on the self-rated 'thermometer', indicating the patient's own assessment of their health state

Examples of the type of information produced from EQ-5D are given in the User Guide.

Age/sex norms have been established for the general population in national surveys conducted in 1993 and replicated in 1995/96.

Comparative data are available from a range of clinical studies conducted in the UK and internationally.

What is EQ-5D being used for?

As an integral part of clinical practice, in monitoring health status of individual patients.

In the evaluation and audit of health care, by measuring changes in health status in individual patients, and in groups of patients.

Establishing levels of population health status both locally and nationally.

Comparison of health status in local communities and practice catchment areas, with national patterns.

In the UK, a NHS Task Group has been set up to co-ordinate the testing of EQ-5D as an outcome measure for use by clinicians and managers.

How is EQ-5D obtained?

EQ-5D is in the public domain, and save for commercial users, there is no fee for its use.

Within the UK, advice and support on the use of EQ-5D can be obtained from several sources, including the Centre for Health Economics, University of York (see contact details below).

Copies of the EQ-5D questionnaire can be obtained from the Centre, together with an abbreviated User Guide. Both are supplied free on request.

International enquiries may also be directed to the EuroQol Group's administrative office in Rotterdam, who can also supply copies of a more comprehensive User Guide.

What is the EuroQol Group?

Set up in 1987, the EuroQol Group is an international network of researchers from different disciplines, including medicine, psychology and economics.

Membership of the Group is open to those who contribute to the further development of EQ-5D, and to investigators with direct experience of its use.

A small administrative office in Rotterdam provides support for the network, and co-ordinates links with external agencies.

EQ-5D is in use in most countries around the world, and has been translated into all major languages. The Group oversees that translation process.

How is the EuroQol Group funded?

Individual researchers contribute a nominal sum for annual membership.

Where commercial interests are involved, a user fee may apply. Contact the Rotterdam office for details. Bids for European funding have been submitted.

Individual members of the EuroQol Group are free to act as consultants in advising on the use of EQ-5D, but may charge accordingly for their services.

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Your own health state today

By placing a tick in one box in each group below, please indicate which statement best describes you own health state today.

Do not tick more than one box in each group.

1. Mobility

1. I have no problems in walking about
2. I have some problems in walking about
3. I am confined to bed

2. Self-Care

1. I have no problems with self-care
2. I have some problems washing or dressing myself
3. I am unable to wash of dress myself

3. Usual Activities (eg. Work, study, housework, family or leisure activities)

1. I have no problem with performing my usual activities
2. I have some problems with performing my usual activities
3. I am unable to perform my usual activities

4. Pain/Discomfort

1. I have no pain or discomfort
2. I have moderate pain or discomfort
3. I have extreme pain or discomfort

5. Anxiety/Depression

1. I am not anxious or depressed
2. I am moderately anxious or depressed
3. I am extremely anxious or depressed

Estimated weights for EQ-5D health states

1 1 1 1 1	1.000	1 2 3 3 2	-0.005	2 1 3 2 3	0.128
1 1 1 1 2	0.848	1 2 3 3 3	-0.170	2 1 3 3 1	0.101
1 1 1 1 3	0.414	1 3 1 1 1	0.436	2 1 3 3 2	0.030
1 1 1 2 1	0.796	1 3 1 1 2	0.365	2 1 3 3 3	-0.135
1 1 1 2 2	0.725	1 3 1 1 3	0.200	2 2 1 1 1	0.746
1 1 1 2 3	0.291	1 3 1 2 1	0.313	2 2 1 1 2	0.675
1 1 1 3 1	0.264	1 3 1 2 2	0.242	2 2 1 1 3	0.241
1 1 1 3 2	0.193	1 3 1 2 3	0.077	2 2 1 2 1	0.623
1 1 1 3 3	0.028	1 3 1 3 1	0.050	2 2 1 2 2	0.552
1 1 2 1 1	0.883	1 3 1 3 2	-0.021	2 2 1 2 3	0.118
1 1 2 1 2	0.812	1 3 1 3 3	-0.186	2 2 1 3 1	0.091
1 1 2 1 3	0.378	1 3 2 1 1	0.400	2 2 1 3 2	0.020
1 1 2 2 1	0.760	1 3 2 1 2	0.329	2 2 1 3 3	-0.145
1 1 2 2 2	0.689	1 3 2 1 3	0.164	2 2 2 1 1	0.710
1 1 2 2 3	0.255	1 3 2 2 1	0.277	2 2 2 1 2	0.639
1 1 2 3 1	0.228	1 3 2 2 2	0.206	2 2 2 1 3	0.205
1 1 2 3 2	0.157	1 3 2 2 3	0.041	2 2 2 2 1	0.587
1 1 2 3 3	-0.008	1 3 2 3 1	0.014	2 2 2 2 2	0.516
1 1 3 1 1	0.556	1 3 2 3 2	-0.057	2 2 2 2 3	0.082
1 1 3 1 2	0.485	1 3 2 3 3	-0.222	2 2 2 3 1	0.055
1 1 3 1 3	0.320	1 3 3 1 1	0.342	2 2 2 3 2	-0.016
1 1 3 2 1	0.433	1 3 3 1 2	0.271	2 2 2 3 3	-0.181
1 1 3 2 2	0.362	1 3 3 1 3	0.106	2 2 3 1 1	0.383
1 1 3 2 3	0.197	1 3 3 2 1	0.219	2 2 3 1 2	0.312
1 1 3 3 1	0.170	1 3 3 2 2	0.148	2 2 3 1 3	0.147
1 1 3 3 2	0.099	1 3 3 2 3	-0.017	2 2 3 2 1	0.260
1 1 3 3 3	-0.066	1 3 3 3 1	-0.044	2 2 3 2 2	0.189
1 2 1 1 1	0.815	1 3 3 3 2	-0.115	2 2 3 2 3	0.024
1 2 1 1 2	0.744	1 3 3 3 3	-0.280	2 2 3 3 1	-0.003
1 2 1 1 3	0.310	2 1 1 1 1	0.850	2 2 3 3 2	-0.074
1 2 1 2 1	0.692	2 1 1 1 2	0.779	2 2 3 3 3	-0.239
1 2 1 2 2	0.621	2 1 1 1 3	0.345	2 3 1 1 1	0.367
1 2 1 2 3	0.187	2 1 1 2 1	0.727	2 3 1 1 2	0.296
1 2 1 3 1	0.160	2 1 1 2 2	0.656	2 3 1 1 3	0.131
1 2 1 3 2	0.089	2 1 1 2 3	0.222	2 3 1 2 1	0.244
1 2 1 3 3	-0.076	2 1 1 3 1	0.195	2 3 1 2 2	0.173
1 2 2 1 1	0.779	2 1 1 3 2	0.124	2 3 1 2 3	0.008
1 2 2 1 2	0.708	2 1 1 3 3	-0.041	2 3 1 3 1	-0.019
1 2 2 1 3	0.274	2 1 2 1 1	0.814	2 3 1 3 2	-0.090
1 2 2 2 1	0.656	2 1 2 1 2	0.743	2 3 1 3 3	-0.255
1 2 2 2 2	0.585	2 1 2 1 3	0.309	2 3 2 1 1	0.331
1 2 2 2 3	0.151	2 1 2 2 1	0.691	2 3 2 1 2	0.260
1 2 2 3 1	0.124	2 1 2 2 2	0.620	2 3 2 1 3	0.095
1 2 2 3 2	0.053	2 1 2 2 3	0.186	2 3 2 2 1	0.208
1 2 2 3 3	-0.112	2 1 2 3 1	0.159	2 3 2 2 2	0.137
1 2 3 1 1	0.452	2 1 2 3 2	0.088	2 3 2 2 3	-0.028
1 2 3 1 2	0.381	2 1 2 3 3	-0.077	2 3 2 3 1	-0.055
1 2 3 1 3	0.216	2 1 3 1 1	0.487	2 3 2 3 2	-0.126
1 2 3 2 1	0.329	2 1 3 1 2	0.416	2 3 2 3 3	-0.291
1 2 3 2 2	0.258	2 1 3 1 3	0.251	2 3 3 1 1	0.273
1 2 3 2 3	0.093	2 1 3 2 1	0.364	2 3 3 1 2	0.202
1 2 3 3 1	0.066	2 1 3 2 2	0.293	2 3 3 1 3	0.037

2 3 3 2 1	0.150	3 1 3 3 3	-0.380	3 3 1 2 2	-0.072
2 3 3 2 2	0.079	3 2 1 1 1	0.232	3 3 1 2 3	-0.237
2 3 3 2 3	-0.086	3 2 1 1 2	0.161	3 3 1 3 1	-0.264
2 3 3 3 1	-0.113	3 2 1 1 3	-0.004	3 3 1 3 2	-0.335
2 3 3 3 2	-0.184	3 2 1 2 1	0.109	3 3 1 3 3	-0.500
2 3 3 3 3	-0.349	3 2 1 2 2	0.038	3 3 2 1 1	0.086
3 1 1 1 1	0.336	3 2 1 2 3	-0.127	3 3 2 1 2	0.015
3 1 1 1 2	0.265	3 2 1 3 1	-0.154	3 3 2 1 3	-0.150
3 1 1 1 3	0.100	3 2 1 3 2	-0.225	3 3 2 2 1	-0.037
3 1 1 2 1	0.213	3 2 1 3 3	-0.390	3 3 2 2 2	-0.108
3 1 1 2 2	0.142	3 2 2 1 1	0.196	3 3 2 2 3	-0.273
3 1 1 2 3	-0.023	3 2 2 1 2	0.125	3 3 2 3 1	-0.300
3 1 1 3 1	-0.050	3 2 2 1 3	-0.040	3 3 2 3 2	-0.371
3 1 1 3 2	-0.121	3 2 2 2 1	0.073	3 3 2 3 3	-0.536
3 1 1 3 3	-0.286	3 2 2 2 2	0.002	3 3 3 1 1	0.028
3 1 2 1 1	0.300	3 2 2 2 3	-0.163	3 3 3 1 2	-0.043
3 1 2 1 2	0.229	3 2 2 3 1	-0.190	3 3 3 1 3	-0.208
3 1 2 1 3	0.064	3 2 2 3 2	-0.261	3 3 3 2 1	-0.095
3 1 2 2 1	0.177	3 2 2 3 3	-0.426	3 3 3 2 2	-0.166
3 1 2 2 2	0.106	3 2 3 1 1	0.138	3 3 3 2 3	-0.331
3 1 2 2 3	-0.059	3 2 3 1 2	0.067	3 3 3 3 1	-0.358
3 1 2 3 1	-0.086	3 2 3 1 3	-0.098	3 3 3 3 2	-0.429
3 1 2 3 2	-0.157	3 2 3 2 1	0.015	3 3 3 3 3	-0.594
3 1 2 3 3	-0.322	3 2 3 2 2	-0.056		
3 1 3 1 1	0.242	3 2 3 2 3	-0.221		
3 1 3 1 2	0.171	3 2 3 3 1	-0.248		
3 1 3 1 3	0.006	3 2 3 3 2	-0.319		
3 1 3 2 1	0.119	3 2 3 3 3	-0.484		
3 1 3 2 2	0.048	3 3 1 1 1	0.122		
3 1 3 2 3	-0.117	3 3 1 1 2	0.051		
3 1 3 3 1	-0.144	3 3 1 1 3	-0.114		
3 1 3 3 2	-0.215	3 3 1 2 1	-0.001		

Unconscious (-0.402)
Note: this value is the mean observed score. It does not result from the regression model.

Source: A1 TARIFF BASED ON UK SURVERY(1993)

Appendix 4 Sensitivity Analysis

Variable		Cost per QALY (£) Carbon dioxide laser	Er:YAG laser
Patient variables			
In patients requesting treatment for scarring, degree psychologically affected (%)			
moderately	*Severely*		
85	15	889	883
67	**33**	**726**	**721**
50	50	621	617
Average age of patients at treatment			
25		**726**	**721**
35		970	963
40		1167	576
Average age at end of benefit			
55		970	963
65		**726**	**721**
75		579	576
Treatment variables			
Average number of treatments			
1		**726**	**721**
2		1451	1442
3		2177	2162
Number of consultations per treatment			
2		704	700
3		**726**	**721**
4		747	742
Percentage of patients having test area (%)			
1		723	718
5		**726**	**721**
10		729	724
Extent of treatment (% of patients)			
Full face	Two units		
25	75	632	628
50	50	**726**	**721**
75	**25**	**819**	814
Patients requiring Retin A cream (%)			
25		724	720
50		**726**	**721**
75		727	722
Percentage of patients requiring general anaesthetic (%) (carbon dioxide laser only)			
2		724	721
5		**726**	**721**
10		729	721
Patients having antibiotics (%)			
25		725	721
50		**726**	**721**
75		726	721
Patients requiring antiviral treatment (%)			
0.5		725	721
1		**726**	**721**
5		726	721

Cost variables		
Cost for full face treatment (£)		
2500	583	579
3780	**726**	**721**
4500	805	801
Cost for two units treated (£)		
1500	659	654
2100	**726**	**721**
3000	825	821
Cost for test area (£)		
250	725	720
315	**726**	**721**
350	726	722
Cost per consultation (£)		
50	696	691
95	**726**	**721**
150	762	757
Cost of Retin-A (£)		
15	725	720
21	**726**	**721**
30	727	722
Cost of General Anaesthetic (£)		
250	725	721
300	**726**	**721**
350	726	721
Cost of antibiotics (£)		
0.50	726	721
0.70	**726**	**721**
1.00	726	721
Cost of antivirals (£)		
20	726	721
29	**726**	**721**
40	726	721

Quality of life variables			
IHQL			
In patients severely psychologically affected (utility value)			
Before	*after*		
0.781	0.781	1646	1631
0.781	0.894	936	929
0.781	**0.970**	**726**	**721**
In patients moderately psychologically affected			
Before	After		
0.894	0.894	1320	1309
0.894	**0.970**	**726**	**721**
0.894	1.000	616	612
Disbenefits and side effects of treatment			
Reduction in QALY per treatment			
Carbon dioxide laser	*Er:YAG laser*		
0.02	0.01	722	717
0.04	**0.03**	**726**	**721**
0.09	0.08	733	728
EuroQol			
In patients severely psychologically affected			
before	After		
0.378	0.812	579	575
0.378	**0.848**	**534**	**530**
0.378	1.000	401	399
In patients moderately psychologically affected			
before	After		
0.812	0.848	461	458
0.848	**0.848**	**534**	**530**
0.848	1.000	321	319
Disbenefits and side effects of treatment			
Reduction in QALY per treatment			
Carbon dioxide laser	*Er:YAG laser*		
0.03	0.03	524	522
0.14	**0.13**	**534**	**530**
0.4	0.4	557	555