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# Table of Contents

- HEADER .......................................................... 1
- ABSTRACT .......................................................... 1
- PLAIN LANGUAGE SUMMARY ....................................... 2
- BACKGROUND ...................................................... 2
- OBJECTIVES ...................................................... 4
- METHODS .......................................................... 4
- RESULTS ........................................................... 8
- DISCUSSION ........................................................ 12
- AUTHORS’ CONCLUSIONS ........................................ 13
- ACKNOWLEDGEMENTS ............................................. 14
- REFERENCES ....................................................... 15
- CHARACTERISTICS OF STUDIES .................................... 18
- DATA AND ANALYSES .............................................. 35
  - Analysis 1.1. Comparison 1 Thalidomide versus aspirin, Outcome 1 Remission of skin lesions. .......... 37
  - Analysis 2.1. Comparison 2 100 mg thalidomide versus 300 mg thalidomide, Outcome 1 Remission of skin lesions. .......................................................... 38
  - Analysis 2.2. Comparison 2 100 mg thalidomide versus 300 mg thalidomide, Outcome 2 Change in ENL severity (proportion improved). ............................ 38
  - Analysis 2.3. Comparison 2 100 mg thalidomide versus 300 mg thalidomide, Outcome 3 Time to next clinical ENL episode ................................................. 39
  - Analysis 2.4. Comparison 2 100 mg thalidomide versus 300 mg thalidomide, Outcome 4 Adverse effects. .......................................................... 39
  - Analysis 3.1. Comparison 3 Pentoxifylline versus thalidomide, Outcome 1 Remission of skin lesions. ..................... 40
  - Analysis 4.1. Comparison 4 Clofazimine versus prednisolone, Outcome 1 Remission of skin lesions. .............................. 40
  - Analysis 4.2. Comparison 4 Clofazimine versus prednisolone, Outcome 2 Time to next clinical ENL episode ................................................. 41
  - Analysis 4.3. Comparison 4 Clofazimine versus prednisolone, Outcome 3 Adverse effects. .............................. 41
  - Analysis 5.1. Comparison 5 Clofazimine versus thalidomide, Outcome 1 Time to next clinical ENL episode .............................. 42
  - Analysis 6.1. Comparison 6 Indomethacin versus prednisolone, Outcome 1 Remission of skin lesions. ................. 42
  - Analysis 6.2. Comparison 6 Indomethacin versus prednisolone, Outcome 2 Change in ENL severity (proportion improved). .............................................. 43
  - Analysis 6.3. Comparison 6 Indomethacin versus prednisolone, Outcome 3 Time to next clinical ENL episode ................................................. 43
  - Analysis 6.4. Comparison 6 Indomethacin versus prednisolone, Outcome 4 Adverse effects. ..................... 44
  - Analysis 7.1. Comparison 7 Indomethacin versus chloroquine, Outcome 1 Change in ENL severity (proportion improved). .............................................. 44
  - Analysis 7.2. Comparison 7 Indomethacin versus chloroquine, Outcome 2 Time to next clinical ENL episode ................................................. 45
  - Analysis 7.3. Comparison 7 Indomethacin versus chloroquine, Outcome 3 Adverse effects. .............................. 45
  - Analysis 8.1. Comparison 8 Indomethacin versus aspirin, Outcome 1 Change in ENL severity (proportion improved). ................................................. 46
  - Analysis 8.2. Comparison 8 Indomethacin versus aspirin, Outcome 2 Time to next clinical ENL episode ................................................. 46
  - Analysis 8.3. Comparison 8 Indomethacin versus aspirin, Outcome 3 Adverse effects. .............................. 47
  - Analysis 9.1. Comparison 9 Levamisole versus placebo, Outcome 1 Change in ENL severity (proportion improved). ................................................. 47
- APPENDICES .......................................................... 47
- WHAT’S NEW ......................................................... 50
- HISTORY ............................................................. 50
- CONTRIBUTIONS OF AUTHORS ..................................... 50
- DECLARATIONS OF INTEREST ........................................ 51
- SOURCES OF SUPPORT ............................................. 51
- DIFFERENCES BETWEEN PROTOCOL AND REVIEW .................... 51
- INDEX TERMS ......................................................... 51
ABSTRACT

Background

Erythema nodosum leprosum (ENL) is a serious immunological complication of leprosy, causing inflammation of skin, nerves, other organs, and general malaise. Many different therapies exist for ENL, but it is unclear if they work or which therapy is optimal.

Objectives

To assess the effects of interventions for erythema nodosum leprosum.

Search methods

We searched the Cochrane Skin Group Specialised Register, the Cochrane Central Register of Controlled Trials (CENTRAL) in The Cochrane Library (Issue 1, 2009), MEDLINE (from 2003), EMBASE (from 2005), LILACS and AMED (from inception), CINAHL (from 1981), and databases of ongoing trials, all in March 2009. We checked reference lists of articles and contacted the American Leprosy Missions in Brazil to locate studies.

Selection criteria

Randomised controlled trials (RCTs) of interventions for ENL in people with leprosy.

Data collection and analysis

Two authors performed study selection, assessed trial quality, and extracted data.

Main results

We included 13 studies with a total of 445 participants. The quality of the trials was generally poor and no results could be pooled due to the treatments being so heterogeneous. Treatment with thalidomide showed a significant remission of skin lesions compared to acetylsalicylic acid (aspirin) (RR 2.43; 95% CI 1.28 to 4.59) (1 trial, 92 participants). Clofazimine treatment was superior to prednisolone (more treatment successes; RR 3.67; 95% CI 1.36 to 9.91) (1 trial, 24 participants), and thalidomide (fewer recurrences; RR 0.08; 95% CI 0.01 to 0.56) (1 trial, 72 participants). We did not find any significant benefit for intravenous betamethasone compared to dextrose (1 trial, 10 participants), pentoxifylline compared to thalidomide (1 trial, 44 participants), indomethacin compared to prednisolone, aspirin or chloroquine treatments (2 trials, 80 participants), or levamisole compared to placebo (1 trial, 12 participants). Mild to moderate adverse events were significantly lower in participants taking 100 mg thalidomide compared to 300 mg thalidomide.
daily (RR 0.46; 95% CI 0.23 to 0.93). Significantly more minor adverse events were reported in participants taking clofazimine compared with prednisolone (RR 1.92; 95% CI 1.10 to 3.35). None of the studies assessed quality of life or economic outcomes.

**Authors’ conclusions**

There is some evidence of benefit for thalidomide and clofazimine, but generally we did not find clear evidence of benefit for interventions in the management of ENL. However, this does not mean they do not work, because the studies were small and poorly reported. Larger studies using clearly defined participants, outcome measures, and internationally recognised scales are urgently required.

**PLAIN LANGUAGE SUMMARY**

**Interventions to treat erythema nodosum leprosum, a complication of leprosy**

Leprosy remains a public health issue in poorer parts of the world. In 2007 there were approximately 255,000 new cases reported worldwide. Leprosy (or Hansen’s disease) is a chronic infectious disease. The skin and peripheral nerves of people with leprosy contain leprosy bacteria. Leprosy can be cured with a combination of antibiotics. The immune system plays an important role in leprosy and determines if and how the disease will develop. The response of the immune system to the antigens of the leprosy bacteria may cause periods of inflammation in the skin and nerves, called reactions. Reactions are the main cause of acute nerve damage and disability in leprosy and occur in about one third of people with leprosy. One type of reaction is erythema nodosum leprosum (ENL), a serious and often chronic complication of leprosy caused by the immune system. People with ENL have red, painful swellings in the skin and often feel ill due to fever and general malaise. There are several treatments for ENL, including the oral drugs prednisolone, thalidomide, and clofazimine. We undertook a systematic review on this topic as it was not clear which treatments were most beneficial.

Our review included 13 randomised controlled trials involving 445 participants. These trials assessed: betamethasone (1 trial), thalidomide (5 trials), pentoxifylline (1 trial), clofazimine (3 trials), indomethacin (2 trials), and levamisole (1 trial). Generally, the quality of the studies was poor and many were too small to identify important clinical differences even if they existed. Three small trials showed benefit for thalidomide and clofazimine treatment in terms of fewer further reactions, more treatment successes, and less relapses of ENL.

Adverse events were reported in most of the trials, but it was often not possible to compare the occurrence of any adverse events between the experimental group and control group. Most adverse events reported were not too serious, and only a few participants could not complete treatment due to serious adverse events or for other reasons.

Whether the interventions improved the quality of life of participants, was not evaluated in any of the trials.

Although we did not find clear benefits in these series of small, poorly-performed studies, this does not mean that these drugs do not work in the treatment of ENL, only that scientific evidence is insufficient. Future studies should be better designed and use clear definitions and outcomes, including long-term outcomes and quality of life measures.

**BACKGROUND**

**Description of the condition**

Leprosy is a chronic infectious disease caused by the bacterium Mycobacterium (M.) leprae. Leprosy bacteria are spread as droplets from the nose of infected and untreated individuals (Barron 1974; Pedley 1976; Job 2008), but the importance of other routes of transmission is unclear. When the immune system fails to respond effectively, the disease will develop. Often, the first sign of leprosy is a patch on the skin, but damage to peripheral nerves may occur as well (ILEP 2001). Leprosy develops in various clinical forms, dependent upon the response of the immune system. The internationally accepted Ridley-Jopling classification for leprosy recognises five different groups across a spectrum: tuberculoid (TT), borderline tuberculoid (BT), borderline (BB), borderline lepromatous (BL), and lepromatous (LL) (Ridley 1966). Across this spectrum, people with tuberculoid leprosy have a strong immune
response, only a few skin patches, and a low bacterial load, while people with lepromatous leprosy have no or very weak cell-mediated immunity for \(M. leprae\), have many skin patches, and a high bacterial load. Most people have one of the borderline forms of leprosy: borderline tuberculoid (BT), mid-borderline (BB), or borderline lepromatous (BL). These forms are less easy to distinguish and less stable, meaning that one can shift from one form to another (Hastings 1988). An additional classification has been developed by the World Health Organization (WHO) and is based on the number of skin lesions only. People with five or less skin lesions are classified as having paucibacillary (PB) leprosy, while people with six or more skin lesions are classified as having multibacillary (MB) leprosy. This classification is often used in practice to decide what type of multiple-drug therapy (MDT) should be given to a person with leprosy (WHO 2000; Lockwood 2007).

Leprosy infection can be treated effectively with a combination of antibiotics. Multiple-drug therapy (MDT) with the antibiotics rifampicin, dapsone, and clofazimine was introduced in the 1980s and is provided free by the World Health Organization (ILEP 2001; WHO 2006). Those with PB leprosy receive treatment (dapsone and rifampicin) for six months and those with MB leprosy are treated with dapsone, rifampicin, and clofazimine for 12 months (WHO 2003). Since the introduction of MDT, the number of people affected by leprosy has decreased substantially. At the beginning of 2008 the prevalence was about 213,000 worldwide. This is the registered number of people on MDT treatment. The number of people newly reported in 2007 was approximately 255,000 (WHO 2008).

The body’s immune response to the leprosy bacillus may also cause so-called ‘reactions’. There are two types of potentially nerve damaging reactions: type 1 reaction or reversal reaction, and type 2 reaction or erythema nodosum leprosum (ENL). Type 1, or reversal reaction, presents as acute inflammation in skin lesions and nerves. Erythema nodosum leprosum presents as new, red, painful and tender swellings in the skin, usually on the legs and arms, and sometimes on the trunk; it varies in severity. When the reaction is mild, only the skin is affected and there may be low-grade fever. When the reaction is severe, the swellings are multiple and may ulcerate, there may be high fever and other organs may be inflamed, such as the nerves, eyes, joints, testes, and lymph nodes. If neuritis is present, it is often less severe than neuritis resulting from type 1 reaction (ILEP 2002; Kahawita 2008). Most people with ENL have acute multiple episodes of ENL or chronic ENL over several years. Few people experience a single acute episode of ENL (Nery 1998; Saunderson 2000; Pocaterra 2006). Single acute ENL reaction can be defined as one ENL episode with no recurrence of ENL whilst receiving prednisolone, no increase in severity requiring an increased steroid dose, and no recurrence after the prednisolone has stopped. Acute multiple ENL reaction is defined as more than one ENL episode with the same characteristics as acute single ENL. Chronic ENL is defined as an episode lasting for more than six months. This could include single and multiple episodes. Distinguishing and recognising these different types of ENL will be useful in individual management and treatment of ENL (Pocaterra 2006).

Erythema nodosum leprosum only occurs in people with borderline lepromatous (BL) and lepromatous (LL) leprosy. These people have high bacterial loads which increase the risk of ENL. The percentage of people diagnosed with ENL differs between countries and studies. Countries in Asia and Brazil report high rates of ENL. A study from India found an overall ENL prevalence of 24% (Pocaterra 2006) and a study from Brazil reported an ENL rate of 31% among people on MB MDT treatment (Nery 1998). Studies that look at BL and LL subgroups rather than the whole MB leprosy group will give better estimations of ENL rates, because only these subgroups are at risk of developing ENL (Walker 2007). An Indian study found that almost 50% of people with LL and 9% of people with BL had ENL (Pocaterra 2006), and in a study from Ethiopia 12% of those with LL and 4% of those with BL developed ENL (Saunderson 2000). Erythema nodosum leprosum may occur before the start of treatment, but usually develops within the first three years after starting multiple-drug therapy (MDT). After completion of treatment, people may still have episodes of ENL for several years, because they have persisting mycobacterial antigens despite successful antibacterial treatment (ILEP 2002; Naafs 2003a).

**Causes and risk factors**

Erythema nodosum leprosum is an immune-mediated complication of leprosy. It is caused partly by deposition of \(M. leprae\) antigen and antibody complexes. These complexes circulate in the blood and may precipitate in tissue, particularly on the wall of small blood vessels, causing acute inflammation (vasculitis) and release of tissue-damaging enzymes in any organ or tissue invaded by the leprosy bacillus. In addition, the immune system activates cells (macrophages and T cells) that attack and kill the bacteria (Lockwood 1996; Naafs 2003b; Kahawita 2008). Risk factors for developing ENL are lepromatous classification, high bacterial loads, and being aged under 40 years (Manandhar 1999; Saunderson 2000; Kumar 2004).

**Impact**

People who have ENL usually feel ill (general malaise, fever) and many organs may be affected. Erythema nodosum leprosum is often a recurrent or chronic condition and requires treatment for a long period. Having repeated episodes of ill health, especially in people who are in an economically active period in their lives may cause a further burden. It may affect male fertility due to inflammation of the testis. Women are affected by having fewer treatment options in their childbearing years due to the side-effects of drugs such as thalidomide (Nery 1998; Saunderson 2000; Pocaterra 2006). Leprosy has a far more negative image than many other diseases, and people with leprosy may suffer stigmatization and isolation. It is not uncommon for people to feel isolated and ostracized by their communities.
other diseases. Having visible signs of leprosy or side-effects from treatment triggers discrimination and stigmatisation (Heijnders 2004; Rafferty 2005). The psychological impact of a chronic and stigmatising condition may be profound.

Description of the intervention

Most therapies for ENL aim to control acute inflammation, relieving the pain and preventing further nerve damage or new episodes. Several treatments are available for ENL.

How the intervention might work

The conventional treatment for mild ENL is rest and anti-inflammatory medication to control the acute inflammatory skin lesions and fever. Aspirin is the most commonly used anti-inflammatory drug, but indomethacin, chloroquine, and colchicine have been tested as well. These different anti-inflammatory drugs have not been formally compared in mild ENL and there is no data to suggest that they are superior to aspirin (ILEP 1996; Lockwood 1996).

For severe ENL, prednisolone and clofazimine are most commonly used. Prednisolone usually acts rapidly by controlling the acute inflammation and relieving the pain, fever, and other signs. The starting dose should be the lowest possible to control ENL and be gradually reduced. The schedule for reducing prednisolone depends on the course of the disease. Erythema nodosum leprosum is often recurrent or chronic and requires high-dose and prolonged courses of prednisolone for the disease to be controlled. This increases the risk of adverse events, such as hypertension or diabetes, and steroid dependency (ILEP 1996; Lockwood 1996). Clofazimine is considered a useful anti-inflammatory drug when corticosteroids are contraindicated or need to be reduced (WHO). However, treatment with clofazimine usually takes four to six weeks to become active and the dose of clofazimine needed to control ENL is higher than the dose used in MDT (ILEP 1996). Disadvantages of continuous high doses of clofazimine are gastrointestinal symptoms (e.g. diarrhoea) and dark discolouration of the skin. These skin changes usually develop within a few weeks after starting clofazimine treatment and may take two or more years to disappear (ILEP 1996; Lockwood 1996).

Another drug used to treat ENL is thalidomide. The effectiveness of thalidomide in ENL is primarily due to its action on the pro-inflammatory cytokine TNF-α (tumour necrosis factor-α) but other mechanisms may contribute to its anti-inflammatory effect (Walker 2007). The seventh WHO Expert Committee on Leprosy considered thalidomide as an effective treatment of severe ENL, and recommended restriction of thalidomide treatment to male or postmenopausal female patients only. Thalidomide should only be given to women of childbearing age when comprehensive contraceptive precautions can be taken, because its use may cause serious birth defects when taken in early pregnancy (WHO 1998). Other therapies have been tested, such as cyclosporin, pentoxifylline, oral zinc, and Mycobacterium w vaccination (Uyemura 1986; Zaheer 1993; Mahajan 1994; Nery 2000). New therapies for other immune-mediated conditions seem promising. Examples are TNF-α antibody treatment, intravenous immunoglobulin, and tenidap (Lockwood 1996). TNF-α antibody treatment (infliximab) has been reported to be successful in the treatment of a single case of recurrent ENL (Faber 2006). However, the person relapsed and eventually required treatment with thalidomide (Faber, personal communication). It is plausible that these therapies may be effective for controlling ENL, but evidence from randomised controlled trials is very limited.

Why it is important to do this review

Erythema nodosum leprosum is a serious immunological complication of leprosy. The complex mechanisms underlying ENL are not yet fully understood, which makes treatment difficult. Corticosteroids, clofazimine, and thalidomide are the drugs of choice for ENL, but all have drawbacks and the optimal regimen has not been established. Alternative therapies have been tested, but it is unclear if they are beneficial, or which one is preferable. The role of newer treatments, such as TNF-α antibody treatment, intravenous immunoglobulin, and tenidap, is not known.

OBJECTIVES

To assess the effects of any therapy or treatment used in the management of ENL.

METHODS

Criteria for considering studies for this review

Types of studies

All randomised controlled trials (RCTs) of any design.

Types of participants

Anyone affected by leprosy with ENL, confirmed by appropriate clinical features. The definition of ENL is: ‘an inflammatory condition, in which people develop crops of tender erythematous subcutaneous skin lesions’. There may be accompanying neuritis, iritis (inflammation of the iris), arthritis, orchitis (inflammation
of the testis), dactylitis (inflammation of the fingers and toes), lymphadenopathy, oedema, and fever. The skin signs are obligatory; the nerve and general signs optional (Smith 2002; Van Brakel 2005).

### Types of interventions
Any therapy for ENL, including:

1. **Systemic corticosteroids**
   - Oral therapies: prednisolone
   - Intravenous therapies: betamethasone, methylprednisolone

2. **Systemic non-steroidal immunomodulatory therapies**
   - Immune modulators: thalidomide, ciclosporin, pentoxifylline
   - Anti-inflammatory therapies: clofazimine, aspirin, chloroquine, colchicine, indomethacin

3. **Diverse therapies**
   - Oral zinc
   - *Mycobacterium w* vaccine

The comparators were no treatment, placebo, usual care (e.g. systemic corticosteroid with or without pentoxifylline), or another listed therapy. We included trials which compared different dosages of the same therapy or different routes of administration (e.g. intravenous versus oral systemic corticosteroids).

### Types of outcome measures

#### Primary outcomes

(a) **The proportion of participants achieving remission of skin lesions**
Remission was defined as the absence of new tender erythematous subcutaneous skin lesions at completion of the ENL therapy, as assessed by a clinician.

(b) **Investigator-assessed change in ENL severity**
The change in ENL severity, compared to baseline, using a grading scale as used in each of the studies.

(c) **Time to next clinical episode of ENL**
Time to next clinical episode of ENL was defined as the time between the last dose of ENL treatment and appearance of new signs of ENL reaction.

(d) **Changes in quality of life**
As assessed using a recognised instrument (generic, dermatology specific, disease specific, or patient-generated index).

#### Timing of outcome assessment

We considered data that had been recorded for four weeks or less from the start of treatment to reflect short-term benefit and these were analysed separately from data that were recorded for more than four weeks from the start of treatment, which we considered to reflect the minimum time period to capture any longer-term benefit.

The short-term assessment (one to four weeks) was considered the primary endpoint, because the definite treatment effects should be visible within the first few weeks. The medium-term assessment (between four weeks and six months) was used as a secondary endpoint. Assessments of more than six months after the start of treatment were considered long-term outcomes.

#### Adverse outcomes

We were looking at a wide range of interventions and could not pre-specify which were the most important/common adverse events. Therefore we have documented the incidence and severity of all recorded local and systemic adverse events, at any time point, in all the included studies.

#### Economic data

Data relating to costs were not reported and we could not address cost implications in the discussion due to lack of data.

### Search methods for identification of studies

We searched the Cochrane Skin Group Specialised Register on 11th March 2009 using the following search terms: (leprosy and type and 2) or lepromatous or lepra* or (erythema and nodosum) or 'ENL' or (leprosy and borderline) or leprosum.
We searched the Cochrane Central Register of Controlled Trials in *The Cochrane Library* (Issue 1, 2009) using the search strategy in Appendix 1.

We searched MEDLINE (from 2003) on 11th March 2009 using the search strategy in Appendix 2.

We searched EMBASE (from 2005) on 11th March 2009 using the search strategy in Appendix 3.

The UK Cochrane Centre (UKCC) has an ongoing project to systematically search MEDLINE and EMBASE for reports of trials which are then included in the Cochrane Central Register of Controlled Trials. Searching has currently been completed in MEDLINE to 2003 and in EMBASE to 2005. Further searching has been undertaken for this review by the Cochrane Skin Group to cover the years that have not been searched by the UKCC.

We searched AMED (Allied and Complementary Medicine, from 1985) on 11th March 2009 using the search strategy in Appendix 4.

We searched LILACS (Latin American and Caribbean Health Science Information database, from 1982) on 11th March 2009 using the search strategy in Appendix 5.

We searched CINAHL (from 1980) on 17th March 2009 using the search strategy in Appendix 6.

### Ongoing Trials

We searched for ongoing trials in the following ongoing trials registers on 17th March 2009 using the search terms 'leprosy', 'erythema nodosum leprosum' and 'type 2 reaction':

- The metaRegister of Controlled Trials [www.controlled-trials.com](http://www.controlled-trials.com)
- The U.S. National Institutes of Health Ongoing Trials Register [www.clinicaltrials.gov](http://www.clinicaltrials.gov)
- The Australian and New Zealand Clinical Trials Registry [www.anzctr.org.au](http://www.anzctr.org.au)
- The World Health Organization International Clinical Trials Registry Platform [www.who.int/trialsearch](http://www.who.int/trialsearch)
- The Ongoing Skin Trials register [www.nottingham.ac.uk/ongoingskintrials](http://www.nottingham.ac.uk/ongoingskintrials)

### Searching other resources

#### Grey literature

We checked the conference proceeding from the International Leprosy Congress (2008) for RCTs and where appropriate the trial authors were contacted for further information.

#### Reference lists

We checked the references of the included studies, but did not identify any further trials.

### Correspondence

Where possible we corresponded with trial authors of studies less than 15 years old about unpublished and ongoing trials. We contacted a technical consultant at the American Leprosy Missions in Brazil for reports of trials from Brazil.

### Adverse effects

We did not do a separate search for adverse events, but we searched within the included studies.

### Language restrictions

There were no language restrictions when we searched for publications. We sought translations of papers in languages other than English. Taixiang Wu interpreted a paper in Chinese, and Brenda Gomes and Marcos Virmond interpreted papers in Portuguese.

### Data collection and analysis

#### Selection of studies

Two authors (NVV, JHR) checked the titles and abstracts identified from the searches. If it was clear that the study did not refer to a randomised controlled trial on erythema nodosum leprosum, it was excluded. If it was unclear, then the full text of the study was obtained for independent assessment by two authors (NVV, JHR). The authors decided which trials fitted the inclusion criteria. Any disagreement was resolved by discussion between the authors. It was not necessary to refer to a third author. We recorded excluded studies and reasons for exclusion in the Characteristics of excluded studies table.

#### Data extraction and management

One author (NVV) entered data onto a data extraction form and a second author (JHR) checked the data. The authors (NVV, JHR) discussed discrepancies between themselves. Missing data were obtained from trial authors where possible. One author (NVV) entered data into RevMan. The authors were not blinded to the names of trial authors, journals, or institutions. For the participants’ and investigators’ global assessments of improvement, the authors translated reported changes in ENL severity into the proportion of participants with improvement greater than minimal. By improvement greater than minimal we meant anything greater than the first category of improvement on a Likert scale, or greater than 50% improvement from baseline on a continuous scale. For the purpose of calculating clinical efficacy, we regarded categories relating to greater than minimal improvement as a treatment success.
All other outcomes were expressed as the actual or percentage change from baseline.

Assessment of risk of bias in included studies
The quality assessment included an evaluation of the following components for each included study, since there is some evidence that these are associated with biased estimates of treatment effect (Juni 2001):
(a) the method of generation of the randomisation sequence;
(b) the method of allocation concealment - it was considered ‘adequate’ if the assignment could not be foreseen;
(c) who was blinded/not blinded (participants, clinicians, outcome assessors);
(d) how many participants were lost to follow-up in each arm (split into post-randomisation exclusion and later losses if possible) and whether participants were analysed in the groups to which they were originally randomised (intention-to-treat principle).
In addition, assessment was made of the following:
(e) degree of certainty that participants have ENL;
(f) baseline comparison for age, sex, duration, and severity of ENL;
(g) whether outcome measures were described adequately.
The information is recorded in the risk of bias table under Characteristics of included studies.

Measures of treatment effect

Dichotomous data
We expressed the results as risk ratio (RR) and 95% confidence intervals (CI) for dichotomous outcomes.

Continuous data
We expressed the results as differences in means (MD) and 95% CI for continuous outcomes. We did not use a standardised mean difference (SMD) since no continuous outcome measures could be combined.

Time-to-event data
We had no time-to-event data to summarise the log hazard ratio and 95% CI.

Unit of analysis issues

Cross-over trials
We analysed cross-over trials using data from the first phase only, but could not pool with parallel design studies due to lack of comparable studies or differences in timing of outcome assessment.

Studies with multiple treatment groups
Where there were multiple intervention groups within a trial, we made pairwise comparisons of similar ENL interventions or ENL active components versus no treatment, placebo, or another ENL intervention.

Other
We did not find any internally controlled trials. We excluded non-randomised controlled studies from the analyses but these were commented on in the Discussion section.

Dealing with missing data
We were not able to conduct an intention-to-treat analysis when participant drop-out led to missing data due to lack of information from trial authors. We contacted trial authors of studies less than 15 years old to provide missing statistics such as standard deviations, but they failed to respond or provide us with the missing data.

Assessment of heterogeneity
We did not assess statistical heterogeneity using the I² statistic, because there were no studies to be pooled.

Assessment of reporting biases
We did not perform funnel plots, because there were fewer than ten poolable studies.

Data synthesis
We did not perform a meta-analysis to calculate a weighted treatment effect across trials, using a random-effects model, because there were no studies with a similar type of ENL intervention or a similar active component. Instead, we summarised the data for each trial.

Subgroup analysis and investigation of heterogeneity
We did not perform further subgroup analysis due to lack of data on different subgroups. The groups were different severity of ENL (mild or severe) and different duration of ENL (single acute, multiple acute, or chronic).

Sensitivity analysis
We did not perform sensitivity analyses examining the effects of excluding study subgroups, e.g. those studies with low methodological quality, since no meta-analyses were performed.
Where there was uncertainty, we contacted the trial authors for clarification. A consumer was part of the review team to ensure the relevance and readability of the final review.

**Results**

**Description of studies**

See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of ongoing studies.

See: Characteristics of included studies; Characteristics of excluded studies.

**Results of the search**

We found 269 citations to potentially relevant trials from the electronic searches. Eight potentially eligible studies were found from references of included trials and reviews. Correspondence with authors and other persons and searching of grey literature revealed one potentially relevant trial. We identified 48 possible studies, of which 13 were RCTs. The search of the Ongoing Trial Registers revealed one ongoing trial.

**Included studies**

We included 13 trials with 445 participants in this review and these are described in the Characteristics of included studies table. Ten studies were published between 1969 and 1985 and three studies between 2002 and 2007. The follow-up period varied from 7 days to 60 weeks in 13 trials and was unclear in 1 trial (Karat 1969).

**Design**

Three trials had a cross-over design (Pearson 1969; Helmy 1971; Waters 1971) and 10 trials had a parallel group design, of which 1 trial had 4 parallel groups (Karat 1969).

**Sample sizes**

The studies involved sample sizes between 9 and 92 participants. Two studies randomised and evaluated ENL reactions of participants (Iyer 1971; Sheskin 1969).

**Setting**

Twelve studies were done in single centres in Brazil, India, Malaysia, Philippines, Singapore, and Venezuela. One study was conducted in multiple centres in India, Mali, Somalia, and Spain (Iyer 1971).

**Interventions**

The included studies examined several interventions.

Systemic corticosteroids:
- infusion of betamethasone in 5% dextrose versus infusion of 5% dextrose (Girdhar 2002; parallel group).

Systemic non-steroidal immunomodulatory therapies:
- thalidomide versus placebo (Pearson 1969; Waters 1971; cross-over; Sheskin 1969; parallel group);
- thalidomide versus acetylsalicylic acid (Iyer 1971; parallel group);
- 100 mg thalidomide regimen versus 300 mg thalidomide regimen (Villahermosa 2005; parallel group);
- pentoxifylline versus thalidomide (Sales 2007; parallel group);
- clofazimine versus placebo (Helmy 1971; cross-over);
- clofazimine versus thalidomide (Iyer 1976; parallel group);
- clofazimine versus prednisolone (Karat 1970; parallel group);
- indomethacin versus prednisolone (Ing 1969; parallel group);
- indomethacin versus chloroquine versus prednisolone versus aspirin (Karat 1969; parallel group);
- levamisole versus placebo (Arora 1985; parallel group).

Diverse therapies:
- no trials assessing any other therapies were found.

Counterventions were reported in 11 trials. These included iron for those with anaemia, anti-leprosy treatments (dapsone or MDT), analgesics (e.g. paracetamol, stibophen), steroids, and diuretics for treating oedema.

**Outcomes**

The primary outcome of remission of skin lesions, measured as the absence of new tender erythematous subcutaneous skin lesions at completion of the ENL therapy, was not explicitly reported in any of the trials. Two trials defined treatment success or improvement including the absence of new ENL lesions (Sheskin 1969; Karat 1970). Three studies reported the resolution of existing skin lesions (Ing 1969; Villahermosa 2005; Sales 2007), and one study reported the number of participants with no further reaction after the first treatment regimen (Iyer 1971).
The secondary outcome of remission of inflammation at other sites was not explicitly reported in any of the trials. Seven trials used different grading scales or scores to assess ENL severity (Karat 1969; Pearson 1969; Helmy 1971; Waters 1971; Arora 1985; Girdhar 2002; Villahermosa 2005). The secondary outcome of time to next clinical episode was not reported in any of the trials, but four trials mentioned recurrence rates of reactions (Karat 1969; Karat 1970; Iyer 1976; Villahermosa 2005). None of the studies measured changes in quality of life.

Six trials recorded data only for four weeks or less from the start of treatment, reflecting short-term benefit (Ing 1969; Sheskin 1969; Helmy 1971; Iyer 1971; Waters 1971; Sales 2007). Three trials had the outcome assessment at medium-term, ranging from four weeks to six months from the start of treatment (Pearson 1969; Karat 1970; Arora 1985). One trial assessed long-term benefit, more than six months after treatment (Girdhar 2002). One trial assessed both short-term and medium-term (Villahermosa 2005), and one trial both medium-term and long-term (Iyer 1976). The timing of outcome assessment was unclear in one trial (Karat 1969).

Adverse effects were not reported in three trials (Arora 1985; Helmy 1971; Iyer 1976). There was great diversity (or heterogeneity) between interventions and methods used to measure outcomes in the trials. None of the studies used similar interventions and comparisons which could be pooled.

**Excluded studies**

We excluded 35 studies and their details can be found in the Characteristics of excluded studies table. Of these 35 studies, 21 were not RCTs, 2 were excluded as they did randomisation by alternation, 10 did not have ENL as inclusion criterion but included participants with lepromatous leprosy in general, 1 was a duplicate study, and 1 was excluded because it described only intake results and was not completed.

**Ongoing studies**

We found one ongoing randomised, single-blind trial examining montelukast in ENL reaction, compared to prednisolone. Enrollment started in December 2006 and took 18 months. Outcome assessment was scheduled 24 weeks after starting treatment.

**Risk of bias in included studies**

The Collaboration’s recommended tool for assessing risk of bias was used (Higgins 2008), the methodological quality of the trials was generally poor. Since no meta-analyses were performed, sensitivity analysis based on methodological quality was not performed. Three trials had a cross-over design (Pearson 1969; Helmy 1971; Waters 1971). The main concerns associated with cross-over trials are: (i) whether the cross-over design is suitable; (ii) whether there is a carry-over effect; (iii) whether only first period data are available; (iv) incorrect analysis; and (v) comparability of results with those from parallel-group trials. None of the trials had a wash-out period between the two interventions, which might have caused a possible carry-over effect, especially in the trial assessing clofazimine that can persist in the body for a long time. We analysed these trials using data from the first phase only if these were available to overcome these concerns.

Two trials evaluated reactions of participants (Sheskin 1969; Iyer 1971). Participants received up to four treatment regimens for each reaction during the trials. This may have led to an overestimate of the effect because the within-patient variance between outcomes of the same person may be smaller than the between-patient variance of outcomes between individuals. We used only data of the first randomised treatment if these were available to overcome this concern.

**Allocation**

None of the trials were clear on how randomisation lists were generated. In two of the trials, the trial authors have clearly reported that concealment of allocation was adequate; both studies had the medication pre-prepared by a drug company (Iyer 1971; Villahermosa 2005).

**Blinding**

Blinding of outcome assessment was attempted for most of the trials. However, the method as to how this was done was generally unclear and poorly described. None of the studies clearly described who (the participants, clinicians, and outcome assessors) was blinded. One trial was an open trial (Iyer 1976): this was a trial with clofazimine, which is known to give skin discolouration.

**Incomplete outcome data**

Information about incomplete outcome data was generally not reported and participant loss to follow-up ranged between 0% and 33%. Seven trials did not report information on incomplete outcome data, but if accepting no mention in the text and no signs of attrition in tables, as a 100% follow-up, all of these trials had a follow-up rate of 100% (Karat 1969; Sheskin 1969; Karat 1970; Iyer 1971; Waters 1971; Iyer 1976; Arora 1985). Two trials with missing outcome data performed intention-to-treat analysis (Pearson 1969; Sales 2007). Two trials (Ing 1969; Girdhar 2002) had participant losses (1/30 participants and 1/10 participants respectively), but it was not clear as to whether intention-to-treat analysis was done. Two trials (Helmy 1971; Villahermosa 2005) with incomplete outcome data (5/15 participants and 1/22 participants respectively) did not perform an intention-to-treat analysis.
Selective reporting
Six trials did not perform a statistical analysis, but only described the results (Ing 1969; Pearson 1969; Helmy 1971; Iyer 1971; Waters 1971; Iyer 1976). One study (Ing 1969) reported in the summary that “indomethacin is effective in treating only mild and moderate cases of ENL”. The summary of one study (Waters 1971) concluded that “nine of the ten participants showed a very significant reduction in steroid requirement”. Another study (Pearson 1969) summarised that “thalidomide was superior to a placebo”. None of these studies provided sufficient evidence (e.g. significant test values) to support these claims.

Other potential sources of bias

Certainty of diagnosis
Five studies specified erythema nodosum leprosum (ENL) in their inclusion criteria (Sheskin 1969; Karat 1970; Iyer 1971; Villahermosa 2005; Sales 2007). Most other studies did not define ENL, but did mention it under the inclusion criteria.

Baseline comparison for age, sex, duration and severity of ENL
Five studies did not provide data for baseline comparison (Karat 1969; Pearson 1969; Helmy 1971; Iyer 1971; Girdhar 2002). Five studies reported some baseline data, but it was unclear whether groups were similar at baseline (Ing 1969; Sheskin 1969; Waters 1971; Iyer 1976; Arora 1985). Two studies reported only two (age and sex) (Sales 2007) or three (age, sex, and duration of ENL) (Villahermosa 2005) of the characteristics being similar in both groups. In one study, all baseline characteristics (age, sex, duration, and severity of ENL) were similar in both groups (Karat 1970).

Explicit outcome measures
Six studies did not clearly describe outcome measures (Karat 1969; Pearson 1969; Helmy 1971; Iyer 1971; Iyer 1976; Arora 1985). The other studies did explicitly mention outcome measures, such as change in ENL severity, improvement, and treatment success.

Effects of interventions
Please see table of Characteristics of included studies. Subgroup analysis was not performed as there were no appropriate studies to pool. Of the 13 studies included, none compared the same interventions or had comparable outcomes. We did not find any trials assessing therapies as listed under diverse therapies.

Timing of outcome assessment
Results have been grouped according to the timing of outcome assessment: short-term (one to four weeks), medium-term (between four weeks and six months), and long-term (more than six months).

Economic data
None of the trials reported economic outcome data.

Primary outcome measure

(a) The proportion of participants achieving remission of skin lesions
None of the studies reported the absence of new skin lesions at the end of therapy. Two studies had outcome measures that were considered to reflect our primary outcome measure. Karat 1970 reported treatment success, including absence of new ENL lesions, and Sheskin 1969 reported improvement, including absence of new ENL lesions, but did not provide separate data of the first randomised treatment regimen for comparison. Five studies reporting differing definitions of remission of skin lesions. One study reported the number of participants with no further reaction after the first treatment regimen, implying absence of new ENL skin lesions (Iyer 1971). Three studies reported the resolution of existing skin lesions (Ing 1969; Villahermosa 2005; Sales 2007).

Systemic corticosteroids
Remission of skin lesions was not reported for any systemic corticosteroid intervention.

Systemic non-steroidal immunomodulatory therapies

Short-term:
Significantly more participants who received thalidomide treatment had no further reaction after seven days, requiring a second treatment regimen, compared to those receiving acetylsalicylic acid (aspirin) treatment (RR 2.43; 95% CI 1.28 to 4.59; n=92; Analysis 1.1) (Iyer 1971). No significant difference in resolution of existing inflamed ENL nodule was found between the 100 mg thalidomide regimen and the 300 mg thalidomide regimen after seven days (RR 1.33; 95% CI 0.64 to 2.79; n=22; Analysis 2.1) (Villahermosa 2005). No significant difference in the resolution of existing inflamed ENL skin nodules was observed between pentoxifylline and thalidomide after 30 days of treatment (RR 1.05;
95% CI 0.74 to 1.49; n=25; Analysis 3.1) (Sales 2007). No significant difference in remission of existing ENL lesions was found between indomethacin and prednisolone after four weeks (RR 2.33; 95% CI 0.76 to 7.13; n=30; Analysis 6.1) (Ing 1969).

**Medium-term:**
One participant, who had received the 300 mg thalidomide regimen, had a successful taper, defined as a complete response after seven days and lack of new acutely inflamed lesions during the six-week taper and for at least two months after stopping thalidomide (Villahermosa 2005). Significantly more treatment successes were observed in the clofazimine group compared to the prednisolone group at the end of 12 weeks of treatment (RR 3.67; 95% CI 1.36 to 9.91; n=24; Analysis 4.1) (Karat 1970).

**Secondary outcome measures**

(a) **The proportion of participants achieving remission of inflammation at other sites**
Remission of inflammations at other sites was not reported in any of the studies. In Iyer 1971, the data was reported inadequately as there was no separate data from the first randomised treatment regimen.

(b) **Investigator-assessed change in ENL severity**
One study used a global assessment score to assess for changes in ENL symptoms (anorexia, arthralgias, chills, malaise, neuritis, orchitis, and fever) (Villahermosa 2005). One study used a grading scale (0 to 3) to assess changes in ENL severity, with higher grades indicating more severe ENL (Arora 1985). One study (Pearson 1969) used an ENL severity score, but did not provide individual participant data or means and standard deviations for comparison. Two studies assessed change in ENL severity using different scoring methods, but provided only sum scores of the weekly scores over the four-week trial period (Helmy 1971; Waters 1971). One study assessed the frequency and severity of ENL, but did not provide data or significant test values for comparison (Girdhar 2002). One study reported control of reaction, but it was unclear how control was defined (Karat 1969). It was unclear whether any of the scales used had been formally validated.

**Systemic corticosteroids**
Change in ENL severity was not reported for any systemic corticosteroid interventions.

**Systemic non-steroidal immunomodulatory therapies**

**Short-term:**
No significant difference in improvement (becoming asymptomatic) was found between the 100 mg thalidomide regimen and the 300 mg thalidomide regimen after seven days of treatment (RR 1.67; 95% CI 0.85 to 3.26; n=22; Analysis 2.2) (Villahermosa 2005).

**Medium-term:**
No significant difference in improvement (change from grade 3 to grade 1 or 0) was observed between levamisole and placebo after three months (RR 0.95; 95% CI 0.36 to 2.49; n=12; Analysis 9.1) (Arora 1985). No significant difference in control of reaction was found between indomethacin and chloroquine (RR 0.95; 95% CI 0.52 to 1.74; n=23; Analysis 7.1), prednisolone (RR 0.65; 95% CI 0.41 to 1.02; n=24; Analysis 6.2) or aspirin (RR 0.89; 95% CI 0.51 to 1.55; n=25; Analysis 8.1) respectively. The duration of the trial and timing of outcome assessment was unclear; the paper stated both a trial period of 90 days and of 12 months (Karat 1969).

(c) **Time to next clinical episode of ENL**
Time to next clinical episode of ENL was not reported in any of the studies. Four studies reported differing definitions of time to next clinical episode of ENL. One study reported recurrence of new lesions by week seven in participants who had achieved remission of existing ENL skin lesions at the end of the first week (Villahermosa 2005). One study reported relapse of ENL within 52 weeks after treatment (Iyer 1976). Two studies reported recurrence of ENL by the end of the trial period in participants whose initial reaction was controlled in this same period (Karat 1969; Karat 1970).

**Systemic corticosteroids**
Time to next clinical episode of ENL was not reported for any systemic corticosteroid interventions.

**Systemic non-steroidal immunomodulatory therapies**

**Medium-term:**
No significant difference in recurrence of new lesions after seven weeks was observed between the 100 mg thalidomide regimen and the 300 mg thalidomide regimen (RR 3.75; 95% CI 0.62 to 21.12), prednisolone (RR 0.65; 95% CI 0.41 to 1.02), aspirin (RR 0.89; 95% CI 0.51 to 1.55) respectively. The duration of the trial and timing of outcome assessment was unclear; the paper stated both a trial period of 90 days and of 12 months (Karat 1969).
No significant difference in recurrence of ENL was found between clofazimine and prednisolone at the end of 12 weeks (RR 0.14; 95% CI 0.02 to 1.04; n=14; Analysis 4.2) (Karat 1970).

**Long-term:**
Results showed significantly less participants with relapse of ENL in the clofazimine group compared to the thalidomide group within 52 weeks after treatment (RR 0.08; 95% CI 0.01 to 0.56; n=72; Analysis 5.1) (Iyer 1976). No significant difference in recurrence of ENL was observed between indomethacin and chloroquine (RR 1.14; 95% CI 0.44 to 2.94; n=15; Analysis 7.2), prednisolone (RR 0.83; 95% CI 0.40 to 1.72; n=20; Analysis 6.3) or aspirin (RR 0.82; 95% CI 0.38 to 1.74; n=17; Analysis 8.2) respectively at the end of the trial period (90 days or 12 months) (Karat 1969).

**Systemic corticosteroids**
Minor adverse events not requiring withdrawal from treatment (swelling of the face, ‘buffalo hump’, striae distensae, and acne) were more often reported in participants who received intravenous dextrose alone and oral steroids per their need to control ENL (control group) compared to those who received intravenous betamethasone in 5% dextrose, but the number of participants with adverse events in each group was not given (Girdhar 2002).

**Systemic non-steroidal immunomodulatory therapies**
Withdrawals from thalidomide treatment were caused by intestinal obstruction (1/12 participants) (Pearson 1969), and worsening of ENL symptoms (3/22 participants) (Villahermosa 2005). Minor adverse events not requiring withdrawal from thalidomide treatment (e.g. mild dermatitis, constipation, nausea, drowsiness, headache, insomnia, dizziness, dryness) were reported, but data for comparison was often unclear or lacking (Pearson 1969; Sheskin 1969; Iyer 1971; Waters 1971; Sales 2007). Significantly less participants in the 100 mg thalidomide regimen group reported any mild to moderate adverse events compared to those in the 300 mg thalidomide regimen group during the seven-week regimen (RR 0.46; 95% CI 0.23 to 0.93; n=22; Analysis 2.4) (Villahermosa 2005). Withdrawals from pentoxifylline were due to gastrointestinal intolerance to the drug (1/24 participants) and fever and continuing lesion inflammation (3/24 participants). Adverse events not requiring withdrawal from pentoxifylline treatment (e.g. gastrointestinal complaints, nausea) were reported in 2/24 participants (Sales 2007). Significantly more participants who received clofazimine had minor adverse events compared to those who received prednisolone (RR 1.92; 95% CI 1.10 to 3.35; n=24; Analysis 4.3). In the clofazimine group all participants had red/black pigmentation. No withdrawals from either clofazimine or prednisolone treatment were reported (Karat 1970). Withdrawal from indomethacin treatment was due to deterioration of ENL (1/16 participants). Minor adverse events (e.g. nausea, dizziness, insomnia) were more frequently reported in participants who received indomethacin (9 events) compared to those who received prednisolone (1 event) (Ing 1969). No significant differences in minor adverse events (e.g. abdominal pain, nausea, headache) were observed between indomethacin and chloroquine (RR 1.09; 95% CI 0.57 to 2.10; n=23; Analysis 7.3), prednisolone (RR 0.92; 95% CI 0.52 to 1.63; n=24; Analysis 6.4) and aspirin (RR 2.23; 95% CI 0.87 to 5.71; n=25; Analysis 8.3) respectively (Karat 1969).

**Adverse events**
Three trials did not report on adverse events (Helmy 1971; Iyer 1976; Arora 1985). The other trials did provide information about adverse events, but often the number of participants with any adverse events in both groups was unclear.

**DISCUSSION**

**Summary of main results**
There are no good controlled trial data on the optimum treatment for controlling the acute phase of ENL. Our review included 13 randomised controlled trials involving 445 participants, and assessed the effects of betamethasone, thalidomide, pentoxifylline, clofazimine, indomethacin, and levamisole in the management of ENL. One trial showed thalidomide treatment to be superior to acetylsalicylic acid treatment (less new reactions requiring further treatment) (Iyer 1971) in the short-term control of ENL. Two trials showed significant longer-term benefits of clofazimine treatment compared to thalidomide (fewer recurrences) or prednisolone (more treatment successes) respectively (Karat 1970; Iyer 1976). Mild to moderate adverse events were significantly higher in participants taking a 300 mg versus 100 mg dose of thalidomide (Villahermosa 2005) and in participants taking clofazimine compared with prednisolone (Karat 1970).

The results should be considered with caution, due to methodological shortcomings. Data extraction of the study of Iyer 1971 was limited to the results of the first randomised treatment regimen to avoid having more than one outcome per participant in the analysis. In the study of Iyer 1976 participants continued on a maintenance dose of either 100 mg clofazimine or 50 mg thalidomide daily during the year after therapy. The study found significantly less recurrences of ENL in the group who received clo-
fazimine therapy and this effect may be due to the persistence of clofazimine in the body over a longer period of time. Karat 1970 tapered the dose of prednisolone (starting at 30 mg daily and tapered off to 5 mg daily), while the dose of clofazimine (300 mg daily) remained the same during the 12-week treatment.

**Overall completeness and applicability of evidence**

The studies identified were not sufficient to address all of the objectives of the review. Two studies had outcome measures that were considered to reflect our primary outcome measure (Sheskin 1969; Karat 1970). Three studies assessed the disappearance of existing ENL skin lesions rather than the absence of new ENL skin lesions at the end of the therapy (Ing 1969; Villahermosa 2005; Sales 2007), and one study reported no further reactions after the first treatment regimen (Iyer 1971). None of the studies reported adequately on the secondary outcome measure: remission of inflammation at other sites upon completion of the ENL therapy, as assessed by a clinician. Seven studies assessed changes in ENL severity using a self-defined definition, scale, or score (Karat 1969; Pearson 1969; Helmy 1971; Waters 1971; Arora 1985; Girdhar 2002; Villahermosa 2005). None of the studies reported on the secondary outcome or time to next clinical episode, but four studies recorded recurrences of ENL in participants whose initial reaction was controlled (Karat 1969; Karat 1970; Iyer 1976; Villahermosa 2005). Adverse events were reported in all but three studies (Helmy 1971; Iyer 1976; Arora 1985). None of the studies assessed the effect of the intervention on quality of life of participants. The studies did not provide separate data for different subgroups, such as disease severity (mild or severe) or duration (single acute, multiple acute, or chronic), while this could have given useful information on effectiveness of treatment for different types of ENL. The results of the studies do not allow any robust conclusion regarding the general applicability of any of the interventions tested.

**Quality of the evidence**

The quality of trials was generally poor, especially in studies published more than 20 years ago, due to the lack of clear reporting of methods, data, and the allocation process. Most of the studies were too small (10 to 92 participants) to identify important differences even if they existed. Three studies had a cross-over design which is associated with increased risk of bias (Pearson 1969; Helmy 1971; Waters 1971). We therefore considered only the first phase treatment. Two studies used more than one outcome of individual participants in the analysis (Sheskin 1969; Iyer 1971). This may have led to an over-estimate of the effect because the within-patient variance between outcomes of the same person may be smaller than the between-patient variance of outcomes between individuals. We used only data of the first randomised treatment to overcome this concern and these were only available for the trial of Iyer 1971. Most of the trials reported comedication, which may have diluted the effect of the intervention tested in the studies. Most of the studies were not clear as to how allocation sequences were generated or how allocation was concealed. Blinding, especially of the outcome assessor, was not described at all or unclear. Trials assessing clofazimine were unblinded the moment skin discoloration appeared. This might have biased the outcome assessments. Six studies reported incomplete outcome data, but only two of those performed an intention-to-treat analysis. Baseline data were poorly reported and absent in five studies. Adverse effects were often reported inadequately, limiting comparisons between experimental and control groups.

**Potential biases in the review process**

The search process was elaborate and to our knowledge no other randomised controlled trials were available for this review. It is possible that not all relevant studies have been included in this review, and that we failed to find some unpublished trials. We contacted several people, but did not identify any new trials. The quality of reporting was generally poor and this may have led to misunderstandings during the critical appraisal of the studies. We contacted authors of studies less than 15 years old, but had poor response to requests for additional information. We were unable to assess for publication bias as there were not enough studies to perform a funnel plot. Most studies were small and showed no significant effect and we considered publication bias in this case not very likely. Some studies, assessing interventions for people with lepromatous leprosy and containing potentially useful data, had to be excluded because no separate results for people with ENL were reported.

**Agreements and disagreements with other studies or reviews**

A few systematic reviews on interventions for ENL have been found, but these focused on thalidomide and included non-randomised studies (Penna 2005; Walker 2007). These reviews concluded that although beneficial effects of thalidomide treatment were found, the evidence is limited due to methodological differences between studies and the use of thalidomide is restricted because of possible serious adverse effects such as teratogenicity, neuropathy, and thromboembolisms.

**Authors’ Conclusions**
Implications for practice

There is some evidence of benefit for thalidomide and clofazimine, but generally we found insufficient evidence to make any firm recommendations on the use of any of the interventions tested for management of ENL and included in this review. This does not mean they do not work, because the studies were generally of poor quality and small-sized.

Treatment with thalidomide showed a significant benefit compared to acetylsalicylic acid (aspirin). Clofazimine treatment was superior to prednisolone and thalidomide. Current guidelines for the management of ENL are given by bodies such as the World Health Organization (WHO) and the International Federation of Anti-Leprosy Associations (ILEP), but these guidelines are not supported by evidence from randomised controlled trials and are developed from practice.

Most of the studies reported adverse effects of treatment. Mild to moderate adverse events were significantly higher in participants taking a 300 mg versus 100 mg dose of thalidomide and in participants taking clofazimine compared with prednisolone. In only a few instances was withdrawal from treatment required, but it was not always clear whether this was due to treatment or for another reason. Adverse effects of commonly used drugs, such as prednisolone, clofazimine, and thalidomide are well-documented and should be kept in mind when prescribing drugs for ENL.

Implications for research

The 13 trials included in this review were generally of poor methodological quality and have mostly been of short duration. A wide range of interventions were assessed, one trial evaluated betamethasone, five trials thalidomide, one trial pentoxifylline, three trials clofazimine, two trials indomethacin, and one trial levamisole.

It was often unclear what the duration and severity of ENL was before the starting of treatment. Future studies should have clearer case definitions for ENL and we recommend that different durations of ENL (single acute episode, multiple acute episode, or chronic) and different severity of ENL (mild or severe) be distinguished, as such subgroups may need different management of ENL.

Erythema nodosum leprosum is a complicated disease known for its unpredictability, its variable severity and duration, and its often chronic and recurrent nature. Although most agents may work similarly for controlling the acute symptoms of ENL, prevention of recurrences is far more difficult.

There is a need for good quality studies which follow the current standards for design and reporting of randomised controlled trials, and for large multi-centre studies to ensure that enough participants are enrolled.

None of the studies investigated whether the interventions improved quality of life of participants and only a few examined the long-term effects of interventions. There is a need for clearly defined outcome measures, both in the short-term and longer-term. We would recommend that future studies include outcomes such as absence of new tender erythematous subcutaneous skin lesions at completion of the ENL therapy, disappearance of inflammation associated with ENL at sites other than the skin (such as iritis and arthritis) at completion of the ENL therapy, as well as time to next clinical episode of ENL after completion of treatment, and quality of life measures.

It is recommended that internationally recognised and validated severity scales be developed so that results from different countries can be compared.

A trial comparing directly prednisolone and thalidomide has never been done, and is urgently needed.

Future studies should aim to assess the efficacy, safety, and optimal regimens of prednisolone and thalidomide for severe ENL and clofazimine for mild ENL as well as other potentially beneficial therapies.

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Girdhar 2002  [published data only]

Helmy 1971  [published data only]

Ing 1969  [published data only]

Iyer 1971  [published data only]

Iyer 1976  [published data only]

Karat 1969  [published data only]

Karat 1970  [published data only]

Pearson 1969  [published data only]

Sales 2007  [published data only]

Sheskin 1969  [published data only]

Villahermosa 2005  [published data only]

Waters 1971  [published data only]

References to studies excluded from this review

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Karat 1971b [published data only]

Levy 1973 [published data only]

Manungo 1982a [published data only]

Manungo 1982b [published data only]

Moreira 1998 [published data only]

Partida-Sanchez 1998 [published data only]

Penna 2005 [published data only]

Pettit 1967 [published data only]

Plock 1976 [published data only]

Ramu 1979 [published data only]

Rodriguez 1974 [published data only]

Sharma 1982 [published data only]

Sharma 1986 [published data only]
Interventions for erythema nodosum leprosum (Review)

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Sheskin 1969a  {published data only}

Sheskin 1971  {published data only}

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Vides 1999  {published data only}

Zaheer 1993  {published data only}

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Heijnders 2004

Higgins 2008

ILEP 1996

ILEP 2001

ILEP 2002

Job 2008

Juni 2001

Kahawita 2008

Kumar 2004

Lockwood 1996

Lockwood 2007

Mahajan 1994

Manandhar 1999
Naafs 2003a  

Naafs 2003b  

Nery 1998  

Nery 2000  

Pedley 1976  

Pocaterra 2006  

Rafferty 2005  

Ridley 1966  

Saunderson 2000  

Smith 2002  

Uyemura 1986  

Van Brakel 2005  

Walker 2007  

WHO 1998  

WHO 2000  

WHO 2003  

WHO 2006  

WHO 2008  

Zaheer 1993  

* Indicates the major publication for the study.
## Characteristics of included studies  *

**Arora 1985**

<table>
<thead>
<tr>
<th>Methods</th>
<th>Design: parallel group</th>
</tr>
</thead>
</table>
| **Participants** | Setting: single centre, hospital, India  
Incl: participants with ENL  
Excl: not stated  
M/F: 11/1  
Age: 14 to 55  
Duration: 0 to 7 years  
Severity: severe  
Randomised: 12 participants  
Evaluable: 12 participants  
Unit of analysis: individual |
| **Interventions** | Experimental group (n=5): levamisole capsules (150 mg daily) on 3 consecutive days repeating every fortnight for 3 months  
Control group (n=7): placebo capsules (dose unknown, daily) on 3 consecutive days repeating every fortnight for 3 months  
Other therapy: iron for anemic participants |
| **Outcomes** | Improvement, defined as complete recovery from reaction, after 3 months |
| Notes | - |

### Risk of bias

<table>
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<tr>
<th>Bias</th>
<th>Authors' judgement</th>
<th>Support for judgement</th>
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<tr>
<td>Adequate sequence generation?</td>
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<td>No information provided</td>
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<tr>
<td>Allocation concealment?</td>
<td>Unclear risk</td>
<td>Unclear, though states ‘coding of drugs was done by other person and decoding at end of study’</td>
</tr>
</tbody>
</table>
| Blinding?  
All outcomes | Unclear risk | Unclear who were blinded, though states trial was double-blind |
| Incomplete outcome data addressed?  
All outcomes | Unclear risk | No mention of attrition in text or tables, suggesting 100% follow-up |
| Free of selective reporting? | Low risk | |
| Free of other bias? | Unclear risk | Not clear as to whether groups were similar at baseline; outcome measures not well-described |
### Girdhar 2002

<table>
<thead>
<tr>
<th>Methods</th>
<th>Design: parallel group</th>
</tr>
</thead>
</table>
| Participants | Setting: single centre, leprosy centre, India  
Incl: lepromatous leprosy with recurrent ENL and on steroids for > 6 months  
Excl: not stated  
M/F: not stated  
Age: not stated  
Duration: not stated  
Severity: not stated  
Randomised: 10 participants  
Evaluable: 9 participants (1 lost to follow-up)  
Unit of analysis: individual |
| Interventions | Experimental group (n=4): infusion of betamethasone in 5% dextrose daily for 3 days every 4 weeks for 6 months  
Control group (n=5): infusion of 5% dextrose daily for 3 days every 4 weeks for 6 months  
Other therapy: MDT with 100 mg clofazimine daily for all participants; oral steroids as per need to control ENL for participants in control group |
| Outcomes | Change in severity and frequency of ENL 6 months after end of treatment  
Steroid requirement  
Side-effects |
| Notes | - |

#### Risk of bias

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<td>Unclear risk</td>
<td>No information about baseline characteristics of both groups</td>
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</table>
### Helmy 1971

<table>
<thead>
<tr>
<th>Methods</th>
<th>Design: cross-over</th>
</tr>
</thead>
</table>
| **Participants** | Setting: single centre, leprosy centre, Malaysia  
Incl: not stated, though included were lepromatous or indefinite leprosy with moderately severe ENL  
Excl: not stated  
M/F: 10/5  
Age: 17 to 67  
Duration: 6 months to 2 years  
Severity: moderately severe ENL  
Randomised: 15 participants  
Evaluable: 10 participants (5 lost to follow-up)  
Unit of analysis: individual |
| **Interventions** | Group A (n=3): clofazimine capsules (100 mg 3 times daily) in weeks 1 to 4, followed by placebo capsules (dose unknown, 3 times daily) in weeks 5 to 8  
Group B (n=7): placebo capsules (100 mg 3 times daily) in weeks 1 to 4, followed by clofazimine capsules (dose unknown, 3 times daily) in weeks 5 to 8  
Other therapy: dapsone (100 mg 2 times daily); stibophen if needed; paracetamol issued twice weekly to be taken freely |
| **Outcomes** | Severity score of ENL |
| **Notes** | The trial consisted of a first control period (2 weeks), first trial period (4 weeks), second trial period (4 weeks), second control period (4 weeks) |

### Risk of bias

<table>
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<td>Allocation concealment?</td>
<td>Unclear risk</td>
<td>Unclear, though states “key of drug allocation was kept in sealed envelope and opened only after analysis of the results”</td>
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<tr>
<td>Blinding? All outcomes</td>
<td>Unclear risk</td>
<td>Participant &amp; clinician: no, outcome assessor: unclear. Trial was designed to be double-blind, but it ceased when discolouration due to clofazimine appeared</td>
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<tr>
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<td>High risk</td>
<td>5 participants lost to follow-up and excluded from analysis</td>
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<td>Free of selective reporting?</td>
<td>Unclear risk</td>
<td>No statistical analysis performed</td>
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<td>Unclear risk</td>
<td>No information about baseline characteristics of both groups; outcome measures not well-described</td>
</tr>
</tbody>
</table>
Methods: Design: parallel group

Participants:
Setting: single centre, Singapore
Incl: lepromatous leprosy and ENL (mild, moderate, or severe)
Excl: not stated
M/F: not stated
Age: not stated
Duration: not stated
Severity: 15 mild, 9 moderate, 6 severe
Randomised: 30 participants
Evaluable: 30 participants, though one participant did not complete 4-week treatment
Unit of analysis: individual

Interventions:
Experimental group (n=16): indomethacin (25 mg 3 times daily) for 1 month
Control group (n=14): prednisolone (5 mg 3 times daily) for 1 month
Other therapy: anti-leprosy drugs were given during 4-week trial period, but no additional analgesics

Outcomes:
Improvement after 4 weeks (e.g. mean change in pain relief, subsidence of lesions)
Side-effects

Notes:

Risk of bias

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<td>All outcomes</td>
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<td></td>
</tr>
<tr>
<td>Incomplete outcome data addressed?</td>
<td>Unclear risk</td>
<td>Not clear as to whether participant who did not complete treatment was included in analysis</td>
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<tr>
<td>All outcomes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Free of selective reporting?</td>
<td>High risk</td>
<td>No statistical evidence, though states “indomethacin is effective in treating only mild and moderate cases of ENL”</td>
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<td>Unclear risk</td>
<td>Not clear as to whether groups were similar at baseline</td>
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</tbody>
</table>
Methods
Design: parallel group

Participants
Setting: multicentre, 4 centres, India, Mali, Somalia, Spain
Incl: clearly demonstrable dermatological signs of acute lepra reactions i.e. erythema nodosum-like lesions or erythema multiforme-like lesions
Excl: severe or life-threatening lepra reactions
M/F: 92 M
Age: 15 to 55+
Duration: not stated
Severity: not stated
Randomised: 214 ENL reactions (of 92 participants)
Evaluable: 214 ENL reactions
Unit of analysis: reaction

Interventions
Experimental group (n=116): thalidomide tablets (100 mg 4 times daily if ≥ 50 kg, or 100 mg 1 to 3 times daily if < 50 kg) for 7 days
Control group (n=98): acetylsalicylic acid tablets (400 mg 4 times daily if ≥ 50 kg, or 400 mg 1 to 3 times daily if < 50 kg) for 7 days
Other therapy: upon admission all drug therapy had to be ceased

Outcomes
No further reactions
Changes in temperature, skin lesions, blood pressure, pulse rate, and blood cell count after 7 days
Side-effects

Notes
Each reaction was treated with a 7-day regimen. A new regimen was allocated to a participant if there was no improvement or if new acute reactions occurred. The statistical design provided for treatment of 4 reactions in each participant, 2 with acetylsalicylic acid, and 2 with thalidomide, the order being random

Risk of bias

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<td>Unclear risk</td>
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</tr>
<tr>
<td>Allocation concealment?</td>
<td>Low risk</td>
<td>Confidential master sheet of drug allocation kept by WHO, bottles with tablets labelled by drug manufacturer according to master sheet</td>
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<tr>
<td>Blinding? All outcomes</td>
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<td>Incomplete outcome data addressed? All outcomes</td>
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<td>No mention of attrition in text or tables, suggesting 100% follow-up</td>
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<tr>
<td>Free of selective reporting?</td>
<td>Unclear risk</td>
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</table>
### Iyer 1971

(Continued)

| Free of other bias? | Unclear risk | No information about baseline characteristics of both groups; outcome measures not well-described |

### Iyer 1976

| Methods | Design: parallel group |

| Participants | Setting: single centre, India  
Incl: male, lepromatous leprosy and prone to recurrent reactive episodes  
Excl: not stated  
M/F: 72 M  
Age: 15 to 54  
Duration: < 6 months to > 4 years  
Severity: moderate, severe  
Randomised: unclear, states “72 participants available for analysis”  
Evaluable: 72 participants  
Unit of analysis: individual |

| Interventions | Experimental group (n=36): clofazimine (100 mg 3 times daily) for 8 weeks, clofazimine (100 mg once a day) for 52 weeks  
Control group (n=36): thalidomide (100 mg 3 times daily) for 8 weeks, thalidomide (25 to 50 mg once a day) for 52 weeks  
Other therapy: dapsone (10 mg/kg/week) during 52 weeks maintenance therapy |

| Outcomes | Time-to-control reaction  
Maintenance of anti-reaction effect after therapy |

| Notes | First 8 weeks (part A) was acute treatment to control reaction as quickly and effectively as possible. Part B (52 weeks) was dosage aimed at maintaining effect |

### Risk of bias

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<tr>
<td>Allocation concealment?</td>
<td>Unclear risk</td>
<td>No information provided</td>
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<tr>
<td>Blinding? All outcomes</td>
<td>High risk</td>
<td>No, open trial, blinding impossible due to skin discolouration from clofazimine</td>
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<tr>
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<td>Unclear risk</td>
<td>No statistical analysis performed</td>
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</table>
### Karat 1969

**Methods**
- Design: parallel group

**Participants**
- Setting: single centre, leprosy centre, India
- Incl: lepromatous leprosy with ENL, > 12 years
- Excl: history or radiological evidence of peptic ulcer, diabetes, TB, hypertension, severe intercurrent infection, acute peripheral nerve paralysis, medical conditions requiring use of other anti-leprosy drugs
- M/F: not stated
- Age: not stated
- Duration: not stated
- Severity: 28 mild, 22 severe
- Randomised: 50 participants
- Evaluable: 50 participants
- Unit of analysis: individual

**Interventions**
- Group 1 (n=11): indomethacin orally (50 mg 3 times daily) in week 1 to 2, (25 mg 3 times daily) in week 3, (25 mg once a day) maintenance
- Group 2 (n=12): chloroquine orally (250 mg 3 times daily) in week 1 to 2, (250 mg 2 times daily) in week 3, (250 mg once a day) maintenance
- Group 3 (n=13): prednisolone orally (5 mg 3 times daily) in week 1 to 2, (5 mg 2 times daily) in week 3, (5 mg once a day) maintenance
- Group 4 (n=14): aspirin orally (1 g 3 times daily) in week 1 to 2, (1 g 2 times daily) in week 3, (500 mg 2 times daily) maintenance
- Other therapy: anti-leprosy drugs were stopped on admission; sedation with phenobarbitone or chlorpromazine if needed; diuretics only when oedema was progressive and uncontrolled by one of the given drugs

**Outcomes**
- Control of reaction
- Recurrence of reaction
- Side-effects

**Notes**
- Duration of trial period unclear, paper states both trial period of 90 days and 12 months

### Risk of bias

**Bias**
- Adequate sequence generation?
  - Unclear risk
  - Unclear, though states “statistically randomised grouping”
- Allocation concealment?
  - Unclear risk
  - Unclear, though states was confidential list
- Blinding?
  - Unclear risk
  - Unclear who were blinded, though states trial was double-blind
### Karat 1969  
*(Continued)*

<table>
<thead>
<tr>
<th>Incomplete outcome data addressed?</th>
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<tbody>
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<td>Free of selective reporting?</td>
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<tr>
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<td>No information about baseline characteristics of both groups; outcome measures not well-described</td>
</tr>
</tbody>
</table>

### Karat 1970

**Methods**

| Design: parallel group |

**Participants**

| Setting: single centre, leprosy centre, India  |
| Incl: history of ≥ 3 severe reactions and with severe current reaction which could not be controlled by antimony, aspirin, or chloroquine  |
| Excl: peptic ulcer, intercurrent acute infections, TB, or malignant lesions  |
| M/F: not stated  |
| Age: not stated  |
| Duration: 4 to 150 months  |
| Severity: severe  |
| Randomised: 24 participants  |
| Evaluable: 24 participants  |
| Unit of analysis: individual  |

**Interventions**

| Experimental group (n=12): clofazimine (100 mg 3 times daily) for 12 weeks  |
| Control group (n=12): prednisolone (10 mg 3 times daily) week 1, (10 mg 2 times daily) week 2, (5 mg 3 times daily) week 3, (10 mg 2 times daily) week 4, (5 mg once daily) weeks 5 to 12  |
| Other therapy: none  |

**Outcomes**

| Treatment success at end of 12 weeks, defined as body temp < 37.2 ºC, no new ENL lesions, no pain in peripheral nerve, no progression of neurological deficit, and iritis quiescent in 2 weeks from starting treatment  |
| Recurrence of reaction during trial  |
| Side-effects  |

**Notes**

| -  |

**Risk of bias**

<table>
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<tr>
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<td>Unclear risk</td>
<td>Unclear, though states “list of random allocations”</td>
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<td>Allocation concealment?</td>
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<td>Unclear, though states “list was prepared earlier and kept confidential at pharmacy”</td>
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Karat 1970  (Continued)

<table>
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<th>Blinding? All outcomes</th>
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Pearson 1969

<table>
<thead>
<tr>
<th>Methods</th>
<th>Design: cross-over</th>
</tr>
</thead>
</table>
| Participants | Setting: single centre, leprosy centre, Malaysia  
Incl: moderately severe ENL  
Excl: not stated  
M/F: 11/1  
Age: not stated  
Duration: 10 months to 3.5 years  
Severity: unclear, though title states was moderately severe ENL  
Randomised: 12 participants  
Evaluable: 12 participants (1 from group B withdrawn from study after 9 weeks)  
Unit of analysis: individual |
| Interventions | Group A (n=not stated): thalidomide tablets (100 mg 3 times daily) for 6 weeks, followed by placebo (dose and frequency unknown) for 6 weeks  
Group B (n=not stated): placebo tablets (dose and frequency not stated) for 6 weeks, followed by thalidomide tablets (100 mg 3 times daily) for 6 weeks  
Other therapy: prednisolone, stibophen, and paracetamol in addition to placebo |
| Outcomes | Change in ENL score  
Steroid requirement  
Side-effects |
| Notes | - |

Risk of bias

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<td>Blinding? All outcomes</td>
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<td>Participant &amp; clinician: yes, outcome assessor: unclear</td>
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### Pearson 1969 (Continued)

<table>
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<tr>
<th>Incomplete outcome data addressed?</th>
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<th></th>
<th>Intention-to-treat analysis performed; average scores for first 3 weeks of thalidomide have been inserted for weeks 10 to 12</th>
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<tr>
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<th></th>
<th>No statistical evidence, though states “thalidomide was superior to a placebo”</th>
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<table>
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<th></th>
<th>No information about baseline characteristics of both groups; outcome measures not well-described</th>
</tr>
</thead>
</table>

### Sales 2007

#### Methods

**Design:** parallel group

#### Participants

- **Setting:** single centre, leprosy centre, Brazil
- **Incl:** MB leprosy, males between 18 to 60 years old, females over 49 (postmenopausal), clinical and histopathological ENL
- **Excl:** Acute neuritis requiring CS, hepatic, renal, mental diseases, diabetes, and/or immune-deficiencies related to HIV
- **M/F:** 38/6
- **Age:** 18 to 69
- **Duration:** not stated
- **Severity:** not stated
- **Randomised:** 44 participants
- **Evaluable:** 44 participants (8 lost to follow-up)
- **Unit of analysis:** individual

#### Interventions

- **Group A (n=24):** pentoxifylline (1.2 g daily) for 30 days
- **Group B (n=20):** thalidomide (300 mg daily) for 30 days
- **Other therapy:** participants with no improvement after 15 days treatment or with severe adverse effects were removed from study and put on recommended regimen of thalidomide or corticosteroids

#### Outcomes

- Improvement at end of 30 days treatment, defined as complete elimination of type 2 reactional skin lesion inflammation, normal body temperature, and/or regression of systemic symptoms
- **Side-effects**

#### Notes

- -

#### Risk of bias

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<td>Allocation concealment?</td>
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</table>
**Blinding?**

<table>
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<tr>
<th>All outcomes</th>
<th>Unclear risk</th>
<th>Unclear who were blinded, though states trial was double-blinded</th>
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**Incomplete outcome data addressed?**

<table>
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<th>Intention-to-treat analysis performed; participants removed from trial were categorised as treatment non-responders</th>
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**Free of selective reporting?**

<table>
<thead>
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</table>

**Free of other bias?**

<table>
<thead>
<tr>
<th>Unclear risk</th>
<th>Unclear if all relevant baseline characteristics were similar</th>
</tr>
</thead>
</table>

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**Sheskin 1969**

**Methods**

<table>
<thead>
<tr>
<th>Design: parallel group</th>
</tr>
</thead>
</table>

**Participants**

| Setting: single centre, hospital/ambulatory, Venezuela |
| Incl: lepromatous leprosy with clearly demonstrable dermatologic, neurologic, or other manifestations of ENL reaction |
| Excl: not stated |
| M/F: 37/15 |
| Age: 17 to 58 |
| Duration: 3 months to 9 years |
| Severity: not stated |
| Randomised: 173 ENL reactions (of 52 participants) |
| Evaluable: 173 ENL reactions |
| Unit of analysis: reaction |

**Interventions**

| Experimental group (n=85): thalidomide tablets (100 mg 4 times daily if > 50 kg, or 6 mg/kg/day if ≤ 50 kg) for 7 days |
| Control group (n=88): placebo tablets (100 mg 4 times daily if > 50 kg, or 6 mg/kg/day if ≤ 50 kg) for 7 days |
| Other therapy: if on sulfone therapy at admission, sulfone therapy was continued; if receiving steroids or adrenocorticotropic hormone (ACTH) for prolonged periods at admission, same dosage was continued |

**Outcomes**

| Total improvement, defined as all dermatologic manifestations in advanced state of remission, no new elements, disappearance of characteristic lepra reaction symptoms after 7 days |
| Side-effects |

**Notes**

| Each reaction was treated with a 7-day regimen. A new regimen was allocated to a participant if there was no improvement. Up to 4 consecutive treatment regimens were given to each participant |

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**Risk of bias**

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Sheskin 1969  (Continued)

<table>
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<th>Unclear, though states &quot;code unknown to investigators and kept elsewhere&quot;</th>
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<td>Unclear who were blinded, though states trial was double-blind</td>
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<td>No mention of attrition in text or tables, suggesting 100% follow-up</td>
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<tr>
<td>Free of selective reporting?</td>
<td>Low risk</td>
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<tr>
<td>Free of other bias?</td>
<td>Unclear risk</td>
<td>Not clear as to whether groups were similar at baseline</td>
</tr>
</tbody>
</table>

Villahermosa 2005

Methods
Design: parallel group

Participants
Setting: single centre, leprosy centre, Philippines  
Incl: lepromatous leprosy, ≥ 18 years, acute histologically confirmed episode of ENL consisting of ≥ 10 skin nodules, with or without systemic symptoms; women only included if evidence of non-childbearing potential  
Excl: incapacitating ENL (bed ridden), severe neuritis, thalidomide ingestion within 30 days or corticosteroid ingestion within 2 weeks of enrollment  
M/F: 22 M  
Age: 18 to 46  
Duration: 0 to 3 years  
Severity: not stated  
Randomised: 22 participants  
Evaluable: 19 (3 lost to follow-up)  
Unit of analysis: individual

Interventions
Group A (n=12): thalidomide capsules, 100 mg daily (2x 50 mg, 4x dummy capsules) in week 1, 50 mg daily (1x 50 mg, 3x dummy capsules) in week 2 to 3, 4x dummy capsules daily in weeks 4 to 7  
Group B (n=10): thalidomide capsules, 300 mg daily (6x 50 mg, 0x dummy capsules) in week 1, 200 mg daily (4x 50 mg, 0x dummy capsules) in week 2 to 3, 100 mg daily (2x 50 mg, 2x dummy capsules) in week 4 to 5, 50 mg daily (1x 50 mg, 3x dummy capsules) in week 6 to 7  
Other therapy: acetaminophen for participants with fever during first 72 hours of study

Outcomes
Resolution of inflamed ENL nodules during initial 7-day treatment  
Global assessment  
Re-emergence of skin lesions during taper  
Week 7 lesion counts  
Recurrence of lesions after taper  
Safety and adverse events
Notes
Week 1 treatment was acute treatment. Participants with complete or partial responses at week 1 were tapered from thalidomide during weeks 2 to 7

Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate sequence generation?</td>
<td>Unclear risk</td>
<td>No information provided</td>
</tr>
<tr>
<td>Allocation concealment?</td>
<td>Low risk</td>
<td>Adequate, coded blister packs by pharmaceutical company</td>
</tr>
<tr>
<td>Blinding? All outcomes</td>
<td>Unclear risk</td>
<td>Participant: yes, clinician &amp; outcome assessor: unclear; though states was double-blind</td>
</tr>
<tr>
<td>Incomplete outcome data addressed?</td>
<td>High risk</td>
<td>Three participants withdrawn from trial and excluded from analysis</td>
</tr>
<tr>
<td>Free of selective reporting?</td>
<td>Low risk</td>
<td></td>
</tr>
<tr>
<td>Free of other bias?</td>
<td>Unclear risk</td>
<td>Unclear if all relevant baseline characteristics were similar</td>
</tr>
</tbody>
</table>

Waters 1971

Methods
Design: cross-over

Participants
Setting: single centre, leprosy centre, Malaysia
Incl: not stated, but included were participants with lepromatous leprosy and histologically confirmed moderately severe or severe chronic ENL
Excl: not stated
M/F: 10 M
Age: 19 to 56
Duration: 9 months to 3.5 years
Severity: moderately severe or severe chronic ENL
Randomised: 9 participants for first 16-week trial, 8 participants for second 24-week trial
Evaluable: 9 participants for first 16-week trial, 8 participants for second 24-week trial
Unit of analysis: individual

Interventions
16-week trial (n=9) and 24-week trial (n=8):
Group A (n=5 or n=3): thalidomide tablets (100 mg 3 times daily) for 4 or 6 weeks, followed by placebo tablets (dose unknown, 3 times daily) for 4 or 6 weeks
Group B (n=4 or n=5): placebo tablets (dose unknown, 3 times daily) for 4 or 6 weeks, followed by thalidomide tablets (100 mg 3 times daily) for 4 or 6 weeks
Other therapy: 100 mg dapsone twice weekly, prednisolone or corticotrophin daily, mild analgesics if needed
### Outcomes

Steroid requirement during trial period
ENL score (temperature, severity)

### Notes

First trial lasted 16 weeks (4 weeks control, 4 weeks A, 4 weeks B, 4 weeks control). The second trial started 11 weeks after completion of first trial. The trial lasted 24 weeks (6 weeks control, 6 weeks A, 6 weeks B, 6 weeks control) and included 8 participants of which 7 participated in the first trial.

### Risk of bias

<table>
<thead>
<tr>
<th>Bias</th>
<th>Authors’ judgement</th>
<th>Support for judgement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adequate sequence generation?</td>
<td>Unclear risk</td>
<td>No information provided</td>
</tr>
<tr>
<td>Allocation concealment?</td>
<td>Unclear risk</td>
<td>Unclear, though states “the code of drug allocation was not revealed to anyone until after the trial was completed”</td>
</tr>
<tr>
<td>Blinding?</td>
<td>Unclear risk</td>
<td>Participant &amp; clinician: yes, outcome assessor: unclear</td>
</tr>
<tr>
<td>Incomplete outcome data addressed?</td>
<td>Unclear risk</td>
<td>No mention of attrition in text or tables, suggesting 100% follow-up</td>
</tr>
<tr>
<td>Free of selective reporting?</td>
<td>High risk</td>
<td>No statistical evidence, though states “nine of the ten participants showed a very significant reduction in steroid requirement”</td>
</tr>
<tr>
<td>Free of other bias?</td>
<td>Unclear risk</td>
<td>Not clear as to whether groups were similar at baseline</td>
</tr>
</tbody>
</table>

### Characteristics of excluded studies [ordered by study ID]

<table>
<thead>
<tr>
<th>Study</th>
<th>Reason for exclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anonymous 1976</td>
<td>Treatment of lepromatous leprosy, not of ENL</td>
</tr>
<tr>
<td>Arruda 1986</td>
<td>Treatment of lepromatous leprosy, not of ENL</td>
</tr>
<tr>
<td>Browne 1981</td>
<td>No RCT</td>
</tr>
<tr>
<td>Dawlah 2002</td>
<td>No RCT</td>
</tr>
<tr>
<td>de Almeida Neto 1981</td>
<td>No separate results for ENL</td>
</tr>
<tr>
<td>de Carsalade 2003</td>
<td>No RCT</td>
</tr>
<tr>
<td>Study</td>
<td>Details</td>
</tr>
<tr>
<td>---------------------------</td>
<td>------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Garbino 2006</td>
<td>No specific treatment of ENL, but treatment of ulnar neuropathy in participants with type 1 and type 2 reactions</td>
</tr>
<tr>
<td>Hastings 1970</td>
<td>No RCT</td>
</tr>
<tr>
<td>Huang 1987</td>
<td>No RCT</td>
</tr>
<tr>
<td>Imkamp 1968</td>
<td>No RCT</td>
</tr>
<tr>
<td>Imkamp 1973</td>
<td>No RCT</td>
</tr>
<tr>
<td>Jamet 1992</td>
<td>Treatment of lepromatous leprosy, not of ENL</td>
</tr>
<tr>
<td>Kar 1988</td>
<td>Randomisation by alternation</td>
</tr>
<tr>
<td>Karat 1971a</td>
<td>Treatment of lepromatous leprosy, not of ENL</td>
</tr>
<tr>
<td>Karat 1971b</td>
<td>Propylaxis treatment, not treatment of ENL</td>
</tr>
<tr>
<td>Levy 1973</td>
<td>No RCT</td>
</tr>
<tr>
<td>Manungo 1982a</td>
<td>Treatment of lepromatous leprosy, not of ENL</td>
</tr>
<tr>
<td>Manungo 1982b</td>
<td>No RCT</td>
</tr>
<tr>
<td>Moreira 1998</td>
<td>No RCT</td>
</tr>
<tr>
<td>Partida-Sanchez 1998</td>
<td>No RCT</td>
</tr>
<tr>
<td>Penna 2005</td>
<td>Only methodology and intake results were described, trial not completed</td>
</tr>
<tr>
<td>Pettit 1967</td>
<td>No RCT</td>
</tr>
<tr>
<td>Plock 1976</td>
<td>No RCT</td>
</tr>
<tr>
<td>Ramu 1979</td>
<td>Randomisation by alternation</td>
</tr>
<tr>
<td>Rodriguez 1974</td>
<td>Treatment of lepromatous and borderline leprosy, not of ENL</td>
</tr>
<tr>
<td>Sharma 1982</td>
<td>No RCT</td>
</tr>
<tr>
<td>Sharma 1986</td>
<td>No RCT</td>
</tr>
<tr>
<td>Sheskin 1969a</td>
<td>No RCT</td>
</tr>
<tr>
<td>Sheskin 1971</td>
<td>No RCT</td>
</tr>
<tr>
<td>Sheskin 1983</td>
<td>No RCT</td>
</tr>
</tbody>
</table>
Sunderkotter 2005 | No RCT
---|---
Vides 1999 | No RCT
Zaheer 1993 | Treatment of multibacillary (MB) leprosy, not of ENL
Zhang 2008 | No RCT

**Characteristics of ongoing studies** [ordered by study ID]

**Salim 2009**

<table>
<thead>
<tr>
<th>Trial name or title</th>
<th>Montelukast in ENL Reaction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Methods</td>
<td>design: parallel groups</td>
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<tr>
<td></td>
<td>randomised controlled trial</td>
</tr>
<tr>
<td></td>
<td>single blind</td>
</tr>
<tr>
<td>Participants</td>
<td>• MB leprosy</td>
</tr>
<tr>
<td></td>
<td>• ENL reaction</td>
</tr>
<tr>
<td></td>
<td>• age 15 to 65</td>
</tr>
<tr>
<td></td>
<td>• weight &gt; 35kg</td>
</tr>
<tr>
<td></td>
<td>• patient willing to participate, including agreeing to investigations and admission</td>
</tr>
<tr>
<td></td>
<td>• adequate past records</td>
</tr>
<tr>
<td></td>
<td>• no steroid received in past 4 weeks</td>
</tr>
<tr>
<td>Interventions</td>
<td>1) prednisolone alone</td>
</tr>
<tr>
<td></td>
<td>2) prednisolone plus montelukast</td>
</tr>
<tr>
<td></td>
<td>3) montelukast alone</td>
</tr>
<tr>
<td></td>
<td>Prednisolone starting at 40 mg daily tapered over 12 weeks. Montelukast 10 mg for 16 weeks</td>
</tr>
<tr>
<td>Outcomes</td>
<td>• absence of new nerve function impairment</td>
</tr>
<tr>
<td></td>
<td>• decrease in ENL score</td>
</tr>
<tr>
<td></td>
<td>• incidence of adverse effects</td>
</tr>
<tr>
<td></td>
<td>Timing of outcome assessment at 24 weeks</td>
</tr>
<tr>
<td>Starting date</td>
<td>December 2006</td>
</tr>
<tr>
<td>Contact information</td>
<td>Abdul H Salim, MBBS: <a href="mailto:dfsalim@citechco.net">dfsalim@citechco.net</a></td>
</tr>
<tr>
<td>Notes</td>
<td></td>
</tr>
</tbody>
</table>
**DATA AND ANALYSES**

Comparison 1. Thalidomide versus aspirin

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Remission of skin lesions</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
</tbody>
</table>

Comparison 2. 100 mg thalidomide versus 300 mg thalidomide

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Remission of skin lesions</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>2 Change in ENL severity</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>(proportion improved)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Time to next clinical ENL episode</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>4 Adverse effects</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
</tbody>
</table>

Comparison 3. Pentoxifylline versus thalidomide

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Remission of skin lesions</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
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</table>

Comparison 4. Clofazimine versus prednisolone

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Remission of skin lesions</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>2 Time to next clinical ENL episode</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>3 Adverse effects</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
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</table>
Comparison 5. Clofazimine versus thalidomide

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Time to next clinical ENL episode</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
</tbody>
</table>

Comparison 6. Indomethacin versus prednisolone

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Remission of skin lesions</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>2 Change in ENL severity</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>(proportion improved)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Time to next clinical ENL episode</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>4 Adverse effects</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
</tbody>
</table>

Comparison 7. Indomethacin versus chloroquine

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Change in ENL severity</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>(proportion improved)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Time to next clinical ENL episode</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>3 Adverse effects</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
</tbody>
</table>

Comparison 8. Indomethacin versus aspirin

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Change in ENL severity</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>(proportion improved)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 Time to next clinical ENL episode</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
<tr>
<td>3 Adverse effects</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
</tbody>
</table>
Comparison 9. Levamisole versus placebo

<table>
<thead>
<tr>
<th>Outcome or subgroup title</th>
<th>No. of studies</th>
<th>No. of participants</th>
<th>Statistical method</th>
<th>Effect size</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Change in ENL severity</td>
<td>1</td>
<td></td>
<td>Risk Ratio (M-H, Random, 95% CI)</td>
<td>Subtotals only</td>
</tr>
</tbody>
</table>

Analysis 1.1. Comparison 1 Thalidomide versus aspirin, Outcome 1 Remission of skin lesions.

Review: Interventions for erythema nodosum leprosum

Comparison: 1 Thalidomide versus aspirin

Outcome: 1 Remission of skin lesions

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>thalidomide</th>
<th>aspirin</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
<th>Weight</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iyer 1971</td>
<td>26/50</td>
<td>9/42</td>
<td></td>
<td></td>
<td>2.43 [1.28, 4.59]</td>
</tr>
</tbody>
</table>

Subtotal (95% CI)

Total events: 26 (thalidomide), 9 (aspirin)

Heterogeneity: not applicable

Test for overall effect: Z = 0.0 (P < 0.00001)
### Analysis 2.1. Comparison 2 100 mg thalidomide versus 300 mg thalidomide, Outcome 1 Remission of skin lesions.

**Review:** Interventions for erythema nodosum leprosum  
**Comparison:** 2 100 mg thalidomide versus 300 mg thalidomide  
**Outcome:** 1 Remission of skin lesions

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>100 mg thalidomide</th>
<th>300 mg thalidomide</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>n/N</td>
<td></td>
<td>n/N</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Villahermosa 2005</td>
<td>8/12</td>
<td>5/10</td>
<td>1.33 [0.64, 2.79]</td>
<td>1.33</td>
<td>[0.64, 2.79]</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td>0.0 [0.0, 0.0]</td>
<td>0.0</td>
<td>[0.0, 0.0]</td>
</tr>
</tbody>
</table>

Total events: 8 (100 mg thalidomide), 5 (300 mg thalidomide)  
Heterogeneity: not applicable  
Test for overall effect: Z = 0.0 (P < 0.00001)

### Analysis 2.2. Comparison 2 100 mg thalidomide versus 300 mg thalidomide, Outcome 2 Change in ENL severity (proportion improved).

**Review:** Interventions for erythema nodosum leprosum  
**Comparison:** 2 100 mg thalidomide versus 300 mg thalidomide  
**Outcome:** 2 Change in ENL severity (proportion improved)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>100 mg thalidomide</th>
<th>300 mg thalidomide</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>n/N</td>
<td></td>
<td>n/N</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Villahermosa 2005</td>
<td>10/12</td>
<td>5/10</td>
<td>1.67 [0.85, 3.26]</td>
<td>1.67</td>
<td>[0.85, 3.26]</td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td>0.0 [0.0, 0.0]</td>
<td>0.0</td>
<td>[0.0, 0.0]</td>
</tr>
</tbody>
</table>

Total events: 10 (100 mg thalidomide), 5 (300 mg thalidomide)  
Heterogeneity: not applicable  
Test for overall effect: Z = 0.0 (P < 0.00001)
### Analysis 2.3. Comparison 2 100 mg thalidomide versus 300 mg thalidomide, Outcome 3 Time to next clinical ENL episode.

Review: Interventions for erythema nodosum leprosum  
Comparison: 2 100 mg thalidomide versus 300 mg thalidomide  
Outcome: 3 Time to next clinical ENL episode  

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>100 mg thalidomide</th>
<th>300 mg thalidomide</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>H Random, 95% CI</td>
<td>H Random, 95% CI</td>
<td></td>
</tr>
<tr>
<td>Villahermosa 2005</td>
<td>6/8</td>
<td>1/5</td>
<td>3.75 [0.62, 22.64]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td>0.0 [0.0, 0.0]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 6 (100 mg thalidomide), 1 (300 mg thalidomide)  
Heterogeneity: not applicable  
Test for overall effect: Z = 0.0 (P < 0.00001)  

### Analysis 2.4. Comparison 2 100 mg thalidomide versus 300 mg thalidomide, Outcome 4 Adverse effects.

Review: Interventions for erythema nodosum leprosum  
Comparison: 2 100 mg thalidomide versus 300 mg thalidomide  
Outcome: 4 Adverse effects  

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>100 mg thalidomide</th>
<th>300 mg thalidomide</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>H Random, 95% CI</td>
<td>H Random, 95% CI</td>
<td></td>
</tr>
<tr>
<td>Villahermosa 2005</td>
<td>5/12</td>
<td>9/10</td>
<td>0.46 [0.23, 0.93]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td>0.0 [0.0, 0.0]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 5 (100 mg thalidomide), 9 (300 mg thalidomide)  
Heterogeneity: not applicable  
Test for overall effect: Z = 0.0 (P < 0.00001)
Analysis 3.1. Comparison 3 Pentoxifylline versus thalidomide, Outcome 1 Remission of skin lesions.

Review: Interventions for erythema nodosum leprosum

Comparison: 3 Pentoxifylline versus thalidomide

Outcome: 1 Remission of skin lesions

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>pentoxifylline</th>
<th>thalidomide</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales 2007</td>
<td>12/14</td>
<td>9/11</td>
<td>1.05 [0.74, 1.49]</td>
<td>1.05 [0.74, 1.49]</td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td><strong>0.0 [0.0, 0.0]</strong></td>
<td><strong>0.0 [0.0, 0.0]</strong></td>
<td></td>
</tr>
<tr>
<td>Total events: 12 (pentoxifylline), 9 (thalidomide)</td>
<td>Total events: 12 (pentoxifylline), 9 (thalidomide)</td>
<td></td>
<td>Heterogeneity: not applicable</td>
<td>Test for overall effect: Z = 0.0 (P &lt; 0.00001)</td>
<td></td>
</tr>
</tbody>
</table>

Analysis 4.1. Comparison 4 Clofazimine versus prednisolone, Outcome 1 Remission of skin lesions.

Review: Interventions for erythema nodosum leprosum

Comparison: 4 Clofazimine versus prednisolone

Outcome: 1 Remission of skin lesions

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>clofazimine</th>
<th>prednisolone</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td><strong>0.0 [0.0, 0.0]</strong></td>
<td><strong>0.0 [0.0, 0.0]</strong></td>
<td></td>
</tr>
<tr>
<td>Total events: 11 (clofazimine), 3 (prednisolone)</td>
<td>Total events: 11 (clofazimine), 3 (prednisolone)</td>
<td></td>
<td>Heterogeneity: not applicable</td>
<td>Test for overall effect: Z = 0.0 (P &lt; 0.00001)</td>
<td></td>
</tr>
</tbody>
</table>
### Analysis 4.2. Comparison 4 Clofazimine versus prednisolone, Outcome 2 Time to next clinical ENL episode.

**Review:** Interventions for erythema nodosum leprosum  
**Comparison:** 4 Clofazimine versus prednisolone  
**Outcome:** 2 Time to next clinical ENL episode

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>clofazimine</th>
<th>prednisolone</th>
<th>Risk Ratio M-H,Random,95% CI</th>
<th>Weight</th>
<th>Risk Ratio M-H,Random,95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karat 1970</td>
<td>1/11</td>
<td>2/3</td>
<td>0.14 [ 0.02, 1.04 ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td><strong>0.0 [ 0.0, 0.0 ]</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 1 (clofazimine), 2 (prednisolone)  
Heterogeneity: not applicable  
Test for overall effect: Z = 0.0 (P < 0.00001)

### Analysis 4.3. Comparison 4 Clofazimine versus prednisolone, Outcome 3 Adverse effects.

**Review:** Interventions for erythema nodosum leprosum  
**Comparison:** 4 Clofazimine versus prednisolone  
**Outcome:** 3 Adverse effects

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>clofazimine</th>
<th>prednisolone</th>
<th>Risk Ratio M-H,Random,95% CI</th>
<th>Weight</th>
<th>Risk Ratio M-H,Random,95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karat 1970</td>
<td>12/12</td>
<td>6/12</td>
<td>1.92 [ 1.10, 3.35 ]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td><strong>0.0 [ 0.0, 0.0 ]</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 12 (clofazimine), 6 (prednisolone)  
Heterogeneity: not applicable  
Test for overall effect: Z = 0.0 (P < 0.00001)
### Analysis 5.1. Comparison 5 Clofazimine versus thalidomide, Outcome 1 Time to next clinical ENL episode.

Review: Interventions for erythema nodosum leprosum

Comparison: 5 Clofazimine versus thalidomide

Outcome: 1 Time to next clinical ENL episode

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>clofazimine</th>
<th>thalidomide</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iyer 1976</td>
<td>1/36</td>
<td>13/36</td>
<td>0.08 [ 0.01, 0.56 ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Subtotal (95% CI)**: 0 0 0.0 [ 0.0, 0.0 ]

Total events: 1 (clofazimine), 13 (thalidomide)
Heterogeneity: not applicable
Test for overall effect: Z = 0.0 (P < 0.00001)

### Analysis 6.1. Comparison 6 Indomethacin versus prednisolone, Outcome 1 Remission of skin lesions.

Review: Interventions for erythema nodosum leprosum

Comparison: 6 Indomethacin versus prednisolone

Outcome: 1 Remission of skin lesions

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>indomethacin</th>
<th>prednisolone</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ing 1969</td>
<td>8/16</td>
<td>3/14</td>
<td>2.33 [ 0.76, 7.13 ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Subtotal (95% CI)**: 0 0 0.0 [ 0.0, 0.0 ]

Total events: 8 (indomethacin), 3 (prednisolone)
Heterogeneity: not applicable
Test for overall effect: Z = 0.0 (P < 0.00001)
### Analysis 6.2. Comparison 6 Indomethacin versus prednisolone, Outcome 2 Change in ENL severity (proportion improved).

**Review:** Interventions for erythema nodosum leprosum  
**Comparison:** 6 Indomethacin versus prednisolone  
**Outcome:** 2 Change in ENL severity (proportion improved)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Indomethacin</th>
<th>Prednisolone</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>H-Random,95% CI</td>
<td></td>
<td>H-Random,95% CI</td>
</tr>
<tr>
<td>Karat 1969</td>
<td>7/11</td>
<td>13/13</td>
<td>0.65 [0.41, 1.02]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
<td><strong>0.0 [0.0, 0.0]</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 7 (indomethacin), 13 (prednisolone)  
Heterogeneity: not applicable  
Test for overall effect: Z = 0.0 (P < 0.00001)

### Analysis 6.3. Comparison 6 Indomethacin versus prednisolone, Outcome 3 Time to next clinical ENL episode.

**Review:** Interventions for erythema nodosum leprosum  
**Comparison:** 6 Indomethacin versus prednisolone  
**Outcome:** 3 Time to next clinical ENL episode

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Indomethacin</th>
<th>Prednisolone</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>H-Random,95% CI</td>
<td></td>
<td>H-Random,95% CI</td>
</tr>
<tr>
<td>Karat 1969</td>
<td>4/7</td>
<td>9/13</td>
<td>0.83 [0.40, 1.72]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td><strong>0</strong></td>
<td><strong>0</strong></td>
<td><strong>0.0 [0.0, 0.0]</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 4 (indomethacin), 9 (prednisolone)  
Heterogeneity: not applicable  
Test for overall effect: Z = 0.0 (P < 0.00001)
### Analysis 6.4. Comparison 6 Indomethacin versus prednisolone, Outcome 4 Adverse effects.

**Review:** Interventions for erythema nodosum leprosum  
**Comparison:** 6 Indomethacin versus prednisolone  
**Outcome:** 4 Adverse effects

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Indomethacin</th>
<th>Prednisolone</th>
<th>Risk Ratio M-H</th>
<th>Weight</th>
<th>Risk Ratio M-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karat 1969</td>
<td>7/11</td>
<td>9/13</td>
<td>0.92 [0.52, 1.63]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td>0.00 [0.00, 0.00]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 7 (indomethacin), 9 (prednisolone)  
Heterogeneity: not applicable  
Test for overall effect: Z = 0.0 (P < 0.00001)  

### Analysis 7.1. Comparison 7 Indomethacin versus chloroquine, Outcome 1 Change in ENL severity (proportion improved).

**Review:** Interventions for erythema nodosum leprosum  
**Comparison:** 7 Indomethacin versus chloroquine  
**Outcome:** 1 Change in ENL severity (proportion improved)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Indomethacin</th>
<th>Chloroquine</th>
<th>Risk Ratio M-H</th>
<th>Weight</th>
<th>Risk Ratio M-H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karat 1969</td>
<td>7/11</td>
<td>8/12</td>
<td>0.95 [0.52, 1.74]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td>0.00 [0.00, 0.00]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 7 (indomethacin), 8 (chloroquine)  
Heterogeneity: not applicable  
Test for overall effect: Z = 0.0 (P < 0.00001)
Analysis 7.2. Comparison 7 Indomethacin versus chloroquine, Outcome 2 Time to next clinical ENL episode.

Review: Interventions for erythema nodosum leprosum
Comparison: 7 Indomethacin versus chloroquine
Outcome: 2 Time to next clinical ENL episode

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Indomethacin</th>
<th>Chloroquine</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karat 1969</td>
<td>4/7</td>
<td>4/8</td>
<td>1.14 [0.44, 2.94]</td>
<td></td>
</tr>
</tbody>
</table>

Subtotal (95% CI)

Total events: 4 (indomethacin), 4 (chloroquine)
Heterogeneity: not applicable
Test for overall effect: Z = 0.0 (P < 0.00001)

Favours indomethacin  Favour chloroquine

Analysis 7.3. Comparison 7 Indomethacin versus chloroquine, Outcome 3 Adverse effects.

Review: Interventions for erythema nodosum leprosum
Comparison: 7 Indomethacin versus chloroquine
Outcome: 3 Adverse effects

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Indomethacin</th>
<th>Chloroquine</th>
<th>Risk Ratio M-H, Random, 95% CI</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Karat 1969</td>
<td>7/11</td>
<td>7/12</td>
<td>1.09 [0.57, 2.10]</td>
<td></td>
</tr>
</tbody>
</table>

Subtotal (95% CI)

Total events: 7 (indomethacin), 7 (chloroquine)
Heterogeneity: not applicable
Test for overall effect: Z = 0.0 (P < 0.00001)
### Analysis 8.1. Comparison 8 Indomethacin versus aspirin, Outcome 1 Change in ENL severity (proportion improved).

**Review:** Interventions for erythema nodosum leprosum  
**Comparison:** 8 Indomethacin versus aspirin  
**Outcome:** 1 Change in ENL severity (proportion improved)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>indomethacin</th>
<th>aspirin</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>n/N</td>
<td>n/N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-H,Random,95% CI</td>
<td>M-H,Random,95% CI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Karat 1969</td>
<td>7/11</td>
<td>10/14</td>
<td>0.89 [ 0.51, 1.55 ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subtotal (95% CI): 0 0 0.0 [ 0.0, 0.0 ]  
Total events: 7 (indomethacin), 10 (aspirin)  
Heterogeneity: not applicable  
Test for overall effect: Z = 0.0 (P < 0.00001)

### Analysis 8.2. Comparison 8 Indomethacin versus aspirin, Outcome 2 Time to next clinical ENL episode.

**Review:** Interventions for erythema nodosum leprosum  
**Comparison:** 8 Indomethacin versus aspirin  
**Outcome:** 2 Time to next clinical ENL episode

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>indomethacin</th>
<th>aspirin</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>n/N</td>
<td>n/N</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>M-H,Random,95% CI</td>
<td>M-H,Random,95% CI</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Karat 1969</td>
<td>4/7</td>
<td>7/10</td>
<td>0.82 [ 0.38, 1.74 ]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Subtotal (95% CI): 0 0 0.0 [ 0.0, 0.0 ]  
Total events: 4 (indomethacin), 7 (aspirin)  
Heterogeneity: not applicable  
Test for overall effect: Z = 0.0 (P < 0.00001)
### Analysis 8.3. Comparison 8 Indomethacin versus aspirin, Outcome 3 Adverse effects.

**Review:** Interventions for erythema nodosum leprosum  
**Comparison:** 8 Indomethacin versus aspirin  
**Outcome:** 3 Adverse effects

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Indomethacin</th>
<th>Aspirin</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>M-H, Random, 95% CI</td>
<td></td>
<td>M-H, Random, 95% CI</td>
</tr>
<tr>
<td>Karat 1969</td>
<td>7/11</td>
<td>4/14</td>
<td>2.23 [0.87, 5.71]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td>0.00 [0.00, 0.00]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 7 (indomethacin), 4 (aspirin)  
Heterogeneity: not applicable  
Test for overall effect: Z = 0.0 (P < 0.00001)

---

### Analysis 9.1. Comparison 9 Levamisole versus placebo, Outcome 1 Change in ENL severity (proportion improved).

**Review:** Interventions for erythema nodosum leprosum  
**Comparison:** 9 Levamisole versus placebo  
**Outcome:** 1 Change in ENL severity (proportion improved)

<table>
<thead>
<tr>
<th>Study or subgroup</th>
<th>Levamisole</th>
<th>Placebo</th>
<th>Risk Ratio</th>
<th>Weight</th>
<th>Risk Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n/N</td>
<td>n/N</td>
<td>M-H, Random, 95% CI</td>
<td></td>
<td>M-H, Random, 95% CI</td>
</tr>
<tr>
<td>Arora 1985</td>
<td>4/7</td>
<td>3/5</td>
<td>0.95 [0.36, 2.49]</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Subtotal (95% CI)</strong></td>
<td>0</td>
<td>0</td>
<td>0.00 [0.00, 0.00]</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total events: 4 (levamisole), 3 (placebo)  
Heterogeneity: not applicable  
Test for overall effect: Z = 0.0 (P < 0.00001)
APPENDICES

Appendix 1. Cochrane Library search strategy

#1(type 2 leprosy):ti,ab,kw or (lepr* reaction):ti,ab,kw or (erythema nodosum) or (erythema nodosum leprosum) or 'ENL':ti,ab,kw or (borderline leprosy):ti,ab,kw or (lepromatous leprosy):ti,ab,kw
#2MeSH descriptor Leprosy, Borderline, this term only
#3MeSH descriptor Leprosy, Lepromatous, this term only
#4(SR-SKIN)
#5(#1 OR #2 OR #3)
#6(#5 AND NOT #4)

Appendix 2. MEDLINE search strategy

1. randomized controlled trial.pt.
2. controlled clinical trial.pt.
3. randomized.ab.
4. placebo.ab.
5. clinical trials as topic.sh.
6. randomly.ab.
7. trial.ti.
8. 1 or 2 or 3 or 4 or 5 or 6 or 7
9. humans.sh.
10. 8 and 9
11. leprosy.mp. or exp LEPROSY/
12. type 2 reaction.mp.
13. lepra reaction.mp.
14. ENL.mp.
15. *Erythema Nodosum/
16. LEPROSY, BORDERLINE/
17. LEPROSY, LEPROMATOUS/
18. 11 and 12
19. 11 and 14
20. 15 or 16 or 17 or 18 or 19
21. 10 and 20

Appendix 3. EMBASE search strategy

1. random$.mp.
2. factorial$.mp.
3. crossover$.mp.
4. placebo$.mp. or PLACEBO/
5. (doubl$ adj blind$).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name]
6. (singl$ adj blind$).mp. [mp=title, abstract, subject headings, heading word, drug trade name, original title, device manufacturer, drug manufacturer name]
7. assign$.mp.
8. volunteer$.mp. or VOLUNTEER/
9. Crossover Procedure/
10. Double Blind Procedure/
11. Randomized Controlled Trial/
12. Single Blind Procedure/
13. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12
14. leprosy.mp. or exp LEPROSY/
15. type 2 reaction.mp.
16. 14 and 15
17. lepra reaction.mp.
18. erythema nodosum leprosum.mp. or exp Erythema Nodosum Leprosum/
19. ENL.mp.
20. borderline leprosy.mp. or exp Borderline Leprosy/
21. lepromatous leprosy.mp. or exp Lepromatous Leprosy/
22. 16 or 17 or 18 or 19 or 20 or 21
23. 13 and 22

Appendix 4. AMED search strategy
1. randomized controlled trial.pt.
2. controlled clinical trial.pt.
3. randomized.ab.
4. placebo.ab.
5. clinical trials as topic.sh.
6. randomly.ab.
7. trial.ti.
8. 1 or 2 or 3 or 4 or 5 or 6 or 7
9. humans.sh.
10. 8 and 9
11. leprosy.mp. or exp LEPROSY/
12. type 2 reaction.mp.
13. 11 or 12
14. 10 and 13

Appendix 5. LILACS search strategy
((Pt RANDOMIZED CONTROLLED TRIAL OR Pt CONTROLLED CLINICAL TRIAL OR Mh RANDOMIZED CONTROLLED TRIALS OR Mh RANDOM ALLOCATION OR Mh DOUBLE-BLIND METHOD OR Mh SINGLE-BLIND METHOD OR Pt MULTICENTER STUDY) OR ((tw ensaio or tw ensayo or tw trial) and (tw azar or tw acaso or tw placebo or tw controle$ or tw aleat$ or tw random$ or (tw duplo and tw cego) or (tw doble and tw ciego) or (tw double and tw blind)) and tw clinic$)) AND NOT ((CT ANIMALS OR MH ANIMALS OR CT RABBITS OR CT MICE OR MH RATS OR MH PRIMATES OR MH DOGS OR MH RABBITS OR MH SWINE) AND NOT (CT HUMAN AND CT ANIMALS)) [Palavras] and ((eritema nudoso leprso) or lepra or (leprorreacion) [Palavras] or lepra lepromatosa) or (lepra bipolar) or (lepra dimorfa intermedia) [Palavras]

Appendix 6. CINAHL search strategy
1. randomized controlled trial.pt.
2. controlled clinical trial.pt.
3. randomized.ab.
4. placebo.ab.
5. clinical trials as topic.sh.
6. randomly.ab.
7. trial.ti.
8. 1 or 2 or 3 or 4 or 5 or 6 or 7
9. humans.sh.
10. 8 and 9
11. leprosy
12. type 2 reaction
13. erythema nodosum leprosum
14. 11 and 12
15. 11 and 13
16. 14 or 15
9. 10 and 16.

WHAT’S NEW

Last assessed as up-to-date: 11 March 2009.

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<td>12 September 2012</td>
<td>Amended</td>
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HISTORY

Protocol first published: Issue 1, 2008
Review first published: Issue 3, 2009

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<td>6 June 2008</td>
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CONTRIBUTIONS OF AUTHORS

Link with editorial base and co-ordinate contributions from co-authors (NvV)
Draft protocol (NvV, DL, WvB, JRJ, JHR)
Run search (NvV, FD)
Identify relevant titles and abstracts from searches (NvV, JHR)
Obtain copies of trials (NvV)
Selection of trials (NvV, JHR)
Extract data from trials (NvV)
Enter data into RevMan (NvV) Check data (JHR)
Carry out analysis (NvV, JHR)
Interpret data (NvV, DL, WvB, JHR)
Draft final review (NvV, DL, WvB, JRJ, JHR)
Update review (NvV)
Guarantor review (NvV)
DECLARATIONS OF INTEREST

DNL has been a paid advisor to the drug company Pharmion (who makes thalidomide) advising them on their application to have thalidomide registered within the EU.

SOURCES OF SUPPORT

Internal sources

• The Netherlands Leprosy Relief, Netherlands.

External sources

• No sources of support supplied

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

In the original published protocol outcomes recorded for four weeks or less from the start of treatment were considered to reflect short-term benefit, and data that were recorded for three months or longer from the start of treatment were considered long-term outcomes. After extracting data, we found that timing of outcome assessment varied between four days and one year from the start of treatment.

We decided that studies with outcomes of four weeks or less from the start of treatment were considered as short-term outcomes. We added medium-term outcomes defined as outcomes between four weeks and six months from the start of treatment and changed long-term outcome assessment to more than six months from the start of treatment.

In the original published protocol we planned for two authors to independently extract the data, but it was more efficient to have one author extract the data and enter it into Review Manager, and a second author to check the data.

INDEX TERMS

Medical Subject Headings (MeSH)

Aspirin [therapeutic use]; Clofazimine [therapeutic use]; Erythema Nodosum [*drug therapy]; Leprostatic Agents [*therapeutic use]; Leprosy, Lepromatous [*drug therapy]; Prednisolone [therapeutic use]; Randomized Controlled Trials as Topic; Remission Induction; Thalidomide [therapeutic use]

MeSH check words

Humans