Current evidence for therapeutic interventions and prognostic factors in polymyalgia rheumatica: a systematic literature review informing the 2015 European League Against Rheumatism/American College of Rheumatology recommendations for the management of polymyalgia rheumatica

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ABSTRACT
To summarise evidence on therapeutic interventions and prognostic factors in polymyalgia rheumatica (PMR). A systematic literature review was conducted using Ovid Medline, Embase, PubMed, CINAHL, Web of Science and the Cochrane Library (1970 through April 2014). Quality of evidence (QoE) of identified studies was appraised by Grading of Recommendations Assessment, Development and Evaluation (GRADE) (interventions) and the Quality In Prognostic Studies (QUIPS) methodologies (prognostic factors). Out of 10 931 titles identified, 52 articles were finally selected. A single study indicated that an initial prednisone dose of 20 mg/day is associated with a lower short-term relapse rate than 10 mg/day but at the cost of a higher rate of adverse events. Another study suggested a comparable efficacy of intramuscular methylprednisolone and oral glucocorticoids (GCs) with lower cumulative GC doses and less weight gain in the former group. Moderate to high QoE (1–2 studies) indicated a benefit of methotrexate in remission rates and cumulative GC doses in early PMR. Anti-tumour necrosis factor α agents are ineffective for PMR treatment. Among prognostic factors, female sex, high erythrocyte sedimentation rate (ESR) and peripheral arthritis were associated in some studies with a higher relapse risk. Women and patients with high ESR also appeared to have a longer duration of treatment. Several studies of varying quality, however, failed to prove these associations. In PMR, evidence for initial GC doses and subsequent tapering regimens is limited. Intramuscular methylprednisolone and methotrexate may be effective GC sparing agents. Female sex, high ESR and peripheral arthritis at disease outset are potential risk factors for a worse prognosis.

INTRODUCTION
There is still a wide heterogeneity in the methods used to treat polymyalgia rheumatica (PMR) that may be subject to personal experience, the setting in which it is managed (ie, primary or specialty care) and to the existence and implementation of national guidelines.1–4 Treatment tailored to the individual is desirable but is hampered by the absence of reliable predictors of long-term disease outcomes.

The objective of this work was to summarise evidence on therapeutic interventions and prognostic factors in PMR informing the panel developing new European League Against Rheumatism (EULAR)/American College of Rheumatology (ACR) recommendations for the management of PMR.4a 4b

METHODS
See online supplementary file S1 for full details.
In brief, we used Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology as a framework.5 The key questions were framed in the PICO (Population, Intervention, Comparator, Outcome) format (box 1). Outcomes were retrieved from a survey among rheumatologists, general practitioners and patients (see online supplementary box S1). A sensitive systematic literature search was conducted by two investigators (CD, YPS) using Ovid MEDLINE, Embase, PubMed, CINAHL, Web of Science and the Cochrane Library databases (from January 1970 until April 2014), applying the thesaurus of PMR, text words, abbreviations and truncated text words (see online supplementary box S2 for key words used for Ovid Medline). The grey literature and clinical trial registries were reviewed and tracked to determine whether additional peer-reviewed articles not identified by the primary search had been published. We excluded all articles that did not report original data, did not study patients with PMR, or that considered patients with PMR and giant cell arteritis (GCA) as a single group. We also excluded all studies on prognostic factors investigating tests that were not routinely available and/or with a <6 months’ follow-up. Quality appraisal of interventional and prognostic studies was performed using GRADE6 7 and the Quality in Prognostic Studies (QUIPS) tool,8 respectively. We attempted to perform meta-analyses (fixed effect methods) for interventional studies whenever possible, whereas for prognostic studies, meta-analysis was impossible because of the large heterogeneity in study design, PMR case definition, measurements and definitions of prognostic factors and outcomes as well as study quality.
Box 1  PICO (=Population, Intervention, Comparator, Outcome) questions

**PICO questions on interventions**

1. In polymyalgia rheumatica (PMR) (P), what is the effect of non-steroidal anti-inflammatory drugs and/or analgesics (I) on outcome (O) compared with glucocorticoids (C)?

2. In PMR (P), what is the effect of short duration of glucocorticoid therapy (I) on outcome (O) compared with long duration of glucocorticoid therapy (C)?

3. In PMR (P), what is the effect of low-dose oral glucocorticoids (<7.5 mg/day of prednisone equivalent) (I) on outcome (O) compared with medium dose of glucocorticoids (> 7.5 mg/day but ≤30 mg/day of prednisone equivalent) (C)?

4. In PMR (P), what is the effect of medium-dose oral glucocorticoids (>7.5 mg/day but ≤30 mg/day of prednisone equivalent) (I) on outcome (O) compared with high dose of glucocorticoids (> 30 mg/day but ≤100 mg/day of prednisone equivalent) (C)?

5. In PMR (P), what is the effect of an oral glucocorticoid dose of >10 mg/day but ≤20 mg/day prednisone equivalent (I) on outcome (O) compared with a dose of >20 mg but ≤30 mg/day of prednisone equivalent (C)?

6. In PMR (P), what is the effect of rapid taper of glucocorticoids (I) on outcome (O) compared with slow taper of glucocorticoids (C)?

7. In PMR (P), what is the effect of intramuscular injection of glucocorticoids (I) on outcome (O) compared with oral glucocorticoids (C)?

8. In PMR (P), what is the effect of administration of oral glucocorticoid therapy in divided doses (morning plus evening) (I) on outcome (O) compared with a single dose (morning only) (C)?

9. In PMR (P), what is the effect of glucocorticoids plus non-biological disease modifying antirheumatic drugs (I) on outcome (O) compared with glucocorticoids alone (C)?

10. In PMR (P), what is the effect of glucocorticoids plus biological agents (I) on outcome (O) compared with glucocorticoids alone (C)?

11. In PMR (P), what is the effect of biological agents (I) on outcome (O) compared with glucocorticoids alone (C)?

12. In PMR (P), what is the effect of glucocorticoids plus non-pharmacological interventions (I) on outcome (O) compared with glucocorticoids alone (C)?

**PICO questions on prognostic factors**

13. In PMR (P), what is the effect of older age at diagnosis (I) on outcome (O) compared with younger age (C)?

14. In PMR (P), what is the effect of female sex (I) on outcome (O) compared with male sex (C)?

15. In PMR (P), what is the effect of high levels of inflammatory markers (ie, erythrocyte sedimentation rate and/or C-reactive protein) at diagnosis (I) on outcome (O) compared with low levels of inflammatory markers (C)?

16. In PMR (P), what is the effect of more active/severe disease at diagnosis (I) on outcome (O) compared with lower disease activity/severity (C)?

17. In PMR (P), what is the effect of the presence of peripheral arthritis at diagnosis (I) on outcome (O) compared with the absence of peripheral arthritis (C)?

18. In PMR (P), what is the effect of longer symptom duration at diagnosis (I) on outcome (O) compared with shorter symptom duration (C)?

19. In PMR (P), what is the effect of concomitant conditions (including cardiovascular disease, cerebrovascular disease, peripheral vascular disease, osteoporosis, hyperlipidaemia, diabetes, hypertension, infection, cataract, glaucoma, peptic ulcer, skin disorders, adiposity, mood disturbances, cognitive disorder) at diagnosis that might be exaggerated by PMR and/or glucocorticoid therapy (I) on outcome (O) compared with the absence of these conditions (C)?

20. In PMR (P), what is the effect of rapid response to glucocorticoids (I) on outcome (O) compared with delayed response?

21. In PMR (P), what is the effect of shared patients’ management by primary and secondary care (I) on outcome (O) compared with management in primary care only?

22. In PMR (P), what is the effect of optimal control management of patients (I) on outcome (O) compared with conventional management (C)?

**RESULTS**

Our initial and update searches yielded n=10 078 and 853 articles, respectively (figure 1). The characteristics of the 52 included studies are shown in table 1 (interventions) and table 2 (prognostic factors).

No study was found describing the effect of short versus long duration of glucocorticoid (GC) therapy (PICO 2), the effect of administration of GCs in divided doses (PICO 8), the prognostic value of shared patients’ management by primary and secondary care (PICO 21) and the relevance of optimal control management of patients compared with conventional management (PICO 22).

The full GRADE profile on interventions and evidence tables on prognostic factors are shown in online supplementary tables S1 and S2, respectively.

**Evidence for therapeutic interventions (PICOs 1–12)**

**Non-steroidal anti-inflammatory drugs compared with GCs (PICO 1)**

Two retrospective studies (n=364) reported a lower rate of vertebral fractures (RR=0.05 (CI 0.0 to 0.78)) among non-steroidal anti-inflammatory drug (NSAID) users than among GCs users, whereas no difference was found in hip and radius fractures. In addition, there was a trend towards a higher rate of cardiovascular events (HR=1.64 (0.99 to 2.70)) and hypertension (RR=1.72 (0.94 to 3.13)) in the NSAID group. The quality of evidence (QoE) for all reported outcomes was very low.

**High versus low initial GC doses (PICOs 3–5)**

A single randomised controlled trial (RCT) with 39 patients with PMR investigated starting doses of 20 mg and 10 mg oral prednisone. We also identified seven retrospective studies with comparisons between >7.5 mg/day and ≤7.5 mg/day, >15 mg/day and ≤15 mg/day, >30 mg/day and >30 mg/day oral prednisone.

The RCT demonstrated a lower relapse rate at 2 months in the higher-dose group than in the lower-dose group (RR=0.16 (0.04 to 0.62), moderate QoE). Whereas the retrospective studies showed contradictory results (all with very low QoE). Patients in...
the high-dose groups, however, appeared to be at a higher risk for GC-related adverse events according to one prospective (RR=11.55 (0.68 to 195.63), very low QoE) and one retrospective study (RR=6.73 (1.84 to 24.56), very low QoE).12 22

Rapid versus slow tapering of glucocorticoids (PICO 6)
A single retrospective study (low QoE, n=364) analysed the effect of fast versus slow GC tapering on relapse risk using statistically modelled ‘tapering constants’. Compared with slow tapering, medium and fast GC dose reduction were linked with a 2.4- and 5.3-fold increased risk, respectively for a first relapse.20

Intramuscular versus oral glucocorticoid therapy (PICO 7)
A single multicentre RCT (12 weeks double-blinded plus 84 weeks open-label) on 60 patients with PMR was identified.13 14 The authors reported a similar efficacy of intramuscular (IM) and oral GCs for remission rates at weeks 12, 48 and 96; however, the QoE decreased from moderate at first to very low at the last visit because of a lack of blinding and increasing imprecision after week 12.

The trial reported a lower cumulative GC dose (mean difference (MD) of 1.1 g and 1.5 g at weeks 24 and 96, respectively; moderate QoE) and less weight at week 96 (MD −2.6 kg) in the IM group compared with the oral GC group. Other GC-related side effects, however, did not differ between the groups.

Conventional synthetic disease-modifying antirheumatic drugs (PICO 9)
We identified four RCTs and one retrospective study testing the use of methotrexate (MTX) at doses of 7.5–10 mg/week.10 11 13 24 27 28 In addition, a retrospective analysis on the use of hydroxychloroquine was found.24

We found moderate to high QoE from one to two studies indicating a benefit of MTX for remission at week 44 (RR=5.22 (1.28 to 21.29)),27 relapse rate at week 76 (RR=0.64 (0.42 to 0.98)),10 discontinuation of GCs at weeks 48 (RR=1.74 (1.15 to 2.64)) and 76 (RR=1.64 (1.15 to 2.35))10 as well as cumulative GC doses at 12 months (meta-analysed effect of two studies: MD 0.51 g (0.6–0.43 g) prednisone).15 27 Additionally, Caporali et al10 reported median cumulative prednisone doses of 2.1 g (IQR=1.96–2.9) and 2.97 g (2.17–3.65) in MTX and control groups, respectively, at week 76.

All analyses from one to four prospective and retrospective studies reporting no benefit of MTX for these outcomes were of very low quality:15 24 27 29 Van der Veen’s study, for example,29 reported no difference in remission and relapse rates between MTX and control groups; however, this trial was limited by a very high drop-out rate (ie, study bias) of 48% (withdrawals for several reasons) and imprecision about the outcomes of interest. The (meta-analysed effect of the) two randomised studies by Ferraccioli et al15 and Nazarinia et al27 reporting no difference between groups in the relapse rate at 12 months were limited by lack of blinding, heterogeneity, indirectness (because different GC doses and relapse criteria were used) and imprecision. Additionally, the intervention and control groups in Ferraccioli’s trial received different prednisone starting doses (25 mg in the MTX group and 15 mg in the control arm).15

For the reduction of GC side effects, one trial reported a better dual energy X-ray absorptiometry result during follow-up in the MTX group than in the control group (MD of bone mineral density 2.7% (CI 3.9% to 1.5%), moderate QoE);15 however, the rate of osteoporotic fractures was similar in both groups according to four studies.10 11 13 29 None of the other GC-related adverse events tested was reduced by MTX treatment.10 11 13 29 The QoE of these results was very low mainly because of study limitations and (serious) imprecision. None of the studies was adequately powered to detect differences in GC-related adverse events.

Hydroxychloroquine was ineffective for reducing relapses as indicated by a single very low QoE retrospective study.24

Biological agents (PICO 10 and 11)
A single 52-week RCT examined the efficacy of infliximab (3 mg/kg body weight) versus placebo in 53 patients with PMR.28 The trial failed to show a benefit of infliximab for primary and secondary efficacy endpoints.
Table 1  Characteristics of studies on interventions

<table>
<thead>
<tr>
<th>Study ID</th>
<th>PICO Design</th>
<th>Duration</th>
<th>Follow-up</th>
<th>PMR criteria</th>
<th>Intervention</th>
<th>Control</th>
<th>No pt.</th>
<th>No female patients (%)</th>
<th>No patients with complete follow-up (%)</th>
<th>Outcomes (time point)</th>
</tr>
</thead>
</table>
| 1991 Catoggio &
1998 Delecroeuillerie &
1998 Dasgupta &
1997 Dolan &
1996 Ferraccioli &
1998 Gabriel &
1987 Kanemaru &
2001 Mackie &
2010 Mackie &
2007 Fu &
2006 Kremer &
2007 Kremer &
2004 Caporali &
2008 Cimmino &
1997 Dolan | Case–control (retro.) &
Case–control (retro.) &
Case–control (retro.) &
Case–control (retro.) &
Case–control (retro.) &
Case–control (retro.) &
Case–control (retro.) &
Case–control (retro.) &
Case–control (retro.) &
Case–control (retro.) &
Case–control (retro.) &
Case–control (retro.) &
Case–control (retro.) | 7 y &
6 m &
12 w &
12 w &
8 y &
2 y &
2 m &
114 w &
5 y &
8 y &
76 w &
90 w &
12 w &
22 y | NR &
NR &
NR &
NR &
24 w &
12–177 w | NR &
NR &
NR &
NR &
NR &
| 2004 Caporali &
2008 Cimmino | R, DB, Mul.+Obs. (prosp.) &
R, DB, Mul.+Obs. (prosp.) | 76 w &
90 w | Chiang MTX 10 mg+OP 25 mg | OP 15–30 mg | OP 7–12 mg | 132 | NR | 132 (100) | Relapse (244876 w) Disc GC (244876 w) GC-sides (76 w) |
| 2005 Kremer &
2007 Kremer &
2009 Kyle &
2013 Lee &
2010 Myklebust | 3 Case–control (retro.) &
3 Case–control (retro.) &
R+Obs. (prosp.) &
Case–control (retro.) &
Case–control (retro.) | 114 w &
5 y &
2 m &
114 w &
5 y | Bird &
Bird &
Jones | OP >15 mg &
OP >15 mg &
OP >15 mg &
OP >15 mg &
OP >15 mg | Disc GC (5 y) Dur. GC therapy Devel. GCA (5 y) |
| 2010 Myklebust | Case–control (retro.) | 8 y | Bird/ Hamrin | OP >10 mg and ≤30 mg | OP ≤10 mg | 175 | 124 (71) | 157 (90) | Disc GC (1, 2 y) |
| 2004 Caporali &
2008 Cimmino | R, DB, Mul.+Obs. (prosp.) &
R, DB, Mul.+Obs. (prosp.) | 76 w &
90 w | Chiang MTX 10 mg+OP 25 mg | OP 15–30 mg | OP 7–12 mg | 132 | NR | 132 (100) | Relapse (244876 w) Disc GC (244876 w) GC-sides (76 w) |
| 2008 Cimmino | R, DB, Mul.+ Obs. (prosp.) | 12 w &
84 w | Jones | IMP 120 mg/3 w (starting dose) | OP 15 mg (starting dose) | 60 | 43 (72) | 49 (82) | Remission (124896 w) Disc GC (96 w) GC-sides (61224 m) Cumul GC (24, 52, 96 w) Mortality (96 w) |
| 1998 Dasgupta | R, Mul. | 12 m | Descript. | MTX 10 mg+OP 25 mg | OP 15 mg | 24 | 22 (92) | 24 (100) | Relapse (12 m) Disc GC (12 m) GC-sides (12 m) Cumul GC (6,12 m) ESR/CRP (12 m) GC-dose <5 mg (12 m) |
| 2004 Caporali &
2008 Cimmino | R, DB, Mul.+Obs. (prosp.) &
R, DB, Mul.+Obs. (prosp.) | 76 w &
90 w | Chiang MTX 10 mg+OP 25 mg | OP 15 mg | 181 | 163 (89) | 181 (100) | GC-sides (varT) |
| 2010 Myklebust | Case–control (retro.) | 114 w | Bird | OP >15 mg | OP ≤15 mg | 39 | NR | 39 (100) | Relapse (2 m) GC-sides (varT) |
| 2004 Caporali &
2008 Cimmino | R, DB, Mul.+Obs. (prosp.) &
R, DB, Mul.+Obs. (prosp.) | 76 w &
90 w | Chiang MTX 10 mg+OP 25 mg | OP 15 mg | 181 | 163 (89) | 181 (100) | GC-sides (varT) |
| 2004 Caporali &
2008 Cimmino | R, DB, Mul.+Obs. (prosp.) &
R, DB, Mul.+Obs. (prosp.) | 76 w &
90 w | Chiang MTX 10 mg+OP 25 mg | OP 15 mg | 181 | 163 (89) | 181 (100) | GC-sides (varT) |
| 2004 Caporali &
2008 Cimmino | R, DB, Mul.+Obs. (prosp.) &
R, DB, Mul.+Obs. (prosp.) | 76 w &
90 w | Chiang MTX 10 mg+OP 25 mg | OP 15 mg | 181 | 163 (89) | 181 (100) | GC-sides (varT) |
| 2004 Caporali &
2008 Cimmino | R, DB, Mul.+ Obs. (prosp.) &
R, DB, Mul.+Obs. (prosp.) | 76 w &
90 w | Chiang MTX 10 mg+OP 25 mg | OP 15 mg | 181 | 163 (89) | 181 (100) | GC-sides (varT) |
| 2004 Caporali &
2008 Cimmino | R, DB, Mul.+Obs. (prosp.) &
R, DB, Mul.+Obs. (prosp.) | 76 w &
90 w | Chiang MTX 10 mg+OP 25 mg | OP 15 mg | 181 | 163 (89) | 181 (100) | GC-sides (varT) |
### Table 1

<table>
<thead>
<tr>
<th>Study ID</th>
<th>RCT</th>
<th>PCO</th>
<th>Design</th>
<th>Duration</th>
<th>Follow-up</th>
<th>PDR criteria</th>
<th>Intervention</th>
<th>Control</th>
<th>No females patients (%)</th>
<th>No female patients (%)</th>
<th>Outcomes (time point)</th>
<th>Remission (44 w)</th>
<th>Relapse (44 w)</th>
<th>Cumul GC (44 w)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007 Salvarani28</td>
<td>R</td>
<td>DB, Mul.</td>
<td>52 w</td>
<td>IFX 3 mg/kg+OP 15 mg</td>
<td>OP 15 mg</td>
<td>31 (61)</td>
<td>47 (92)</td>
<td>Relapse (22, 52 w)</td>
<td>GC-sides (52 w)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1996 van der Veen</td>
<td>R</td>
<td>DB, Mul.</td>
<td>2 y</td>
<td>MTX 7.5 mg+OP 20 mg</td>
<td>OP 20 mg</td>
<td>30 (75)</td>
<td>21 (53)</td>
<td>Remission (104 w)</td>
<td>GC-sides (24 m)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1995 Wang</td>
<td>R</td>
<td>BIqi-OP 10 mg</td>
<td>12 w</td>
<td>BIqi-OP 10 mg</td>
<td>OP 10 mg</td>
<td>30 (72)</td>
<td>NR</td>
<td>Response (12 w)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Articles containing both data on interventions and prognostic factors are shown in bold. Studies are listed in alphabetical order; † mean, ‡ median; #, & or ¥ multiple papers on partially the same cohort; * patients with first relapse analysed; ** included two randomised studies reported outcomes, †† reported outcomes, ‡‡ reported outcomes.


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Another RCT compared etanercept with placebo in patients with newly diagnosed PMR not receiving GCs. This trial failed to show a greater reduction of the PMR activity score at week 2 with etanercept than with placebo (primary endpoint) (low QoE).

### Non-pharmacological interventions (PICO 12) and herbal preparations

No clinical trials on non-pharmacological interventions were found.

For herbal preparations, we identified two randomised studies testing Chinese Yanghe herb decoction and Chinese Biqi capsules. Treatment with Chinese Yanghe resulted in a lower degree of morning stiffness and a lower erythrocyte sedimentation rate (ESR) at week 12 (low and moderate QoE, respectively). For Biqi capsules there was low QoE, indicating a higher response rate at week 12 using a new (not validated) clinical composite score (RR=1.4 (1.0 to 2.0)).

### Evidence for prognostic factors (PICOs 13–22)

#### Older versus younger age (PICO 13)

Four studies (n=480, low risk of bias (LoB) in three to six out of eight QUIPS+two categories) examined the prognostic relevance of age. In one study, older age was associated with lower healthcare resource use (n=364, LoB 6/8).

#### Female versus male sex (PICO 14)

The prognostic impact of sex was investigated by 21 studies (n=1811) with varying quality (LoB in 3–6/8). A higher number of relapses in women was found in one study (n=80, LoB 5/8), whereas eight studies (n=693, LoB ranging from 3 to 6/8) showed no such association. One study each reported a lower discontinuation rate of GCs after 1 and 2 years in one study (n=199, LoB 5/8), a longer duration of GC therapy in two studies (n=208, LoB 4/8), and a higher cumulative GC dose (n=80, LoB 4/8). Additionally, GC side effects were generally more common among women than men (three studies, total n=196, LoB 2–4/8).

#### Higher versus lower acute phase reactants (PICO 15)

Acute phase reactants were examined by 16 studies (n=2067). The parameter most commonly investigated was ESR, whereas C-reactive protein (six studies, n=722), interleukin 6 (one study, n=944) and plasma viscosity (one study, n=183) were less frequently tested. For this report, we focused on ESR as results for other acute phase reactants were comparable.

A higher ESR was associated with a higher relapse rate in three studies (n=208, LoB 4–5/8), a longer duration of GC therapy in two studies (n=381, LoB 2–5/8) and a lower probability of GC discontinuation after 1 and 2 years in one study (n=199, LoB 5/8). A higher ESR was associated with a higher relapse rate in three studies (n=208, LoB 4–5/8), a longer duration of GC therapy in two studies (n=381, LoB 2–5/8) and a lower probability of GC discontinuation after 1 and 2 years in one study (n=199, LoB 5/8). A higher ESR was associated with a higher relapse rate in three studies (n=208, LoB 4–5/8), a longer duration of GC therapy in two studies (n=381, LoB 2–5/8) and a lower probability of GC discontinuation after 1 and 2 years in one study (n=199, LoB 5/8). A higher ESR was associated with a higher relapse rate in three studies (n=208, LoB 4–5/8), a longer duration of GC therapy in two studies (n=381, LoB 2–5/8) and a lower probability of GC discontinuation after 1 and 2 years in one study (n=199, LoB 5/8). A higher ESR was associated with a higher relapse rate in three studies (n=208, LoB 4–5/8), a longer duration of GC therapy in two studies (n=381, LoB 2–5/8) and a lower probability of GC discontinuation after 1 and 2 years in one study (n=199, LoB 5/8). A higher ESR was associated with a higher relapse rate in three studies (n=208, LoB 4–5/8), a longer duration of GC therapy in two studies (n=381, LoB 2–5/8) and a lower probability of GC discontinuation after 1 and 2 years in one study (n=199, LoB 5/8). A higher ESR was associated with a higher relapse rate in three studies (n=208, LoB 4–5/8), a longer duration of GC therapy in two studies (n=381, LoB 2–5/8) and a lower probability of GC discontinuation after 1 and 2 years in one study (n=199, LoB 5/8).
Table 2: Characteristics of studies on prognostic factors

<table>
<thead>
<tr>
<th>Study ID</th>
<th>PICO Design</th>
<th>Dur. Follow-up</th>
<th>PMR criteria</th>
<th>Prognostic factor</th>
<th>No pt.</th>
<th>No female (%)</th>
<th>No pt. with complete follow-up (%)</th>
<th>Outcomes (time point)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985 Ayoub¹³</td>
<td>31 Case-control (retro.)</td>
<td>8 y NR</td>
<td>Descript.</td>
<td>Sex</td>
<td>76</td>
<td>42 (55)</td>
<td>76 (100)</td>
<td>GC-sides (varT)</td>
</tr>
<tr>
<td>2008 Barraclough³²</td>
<td>32 Case-control (retro.)</td>
<td>10 y 2 y</td>
<td>Clinical</td>
<td>Sex, ESR, CRP, PV</td>
<td>183</td>
<td>138 (75)</td>
<td>183 (100)</td>
<td>Longer duration GC therapy</td>
</tr>
<tr>
<td>2000 Cantini³³</td>
<td>15 Obs. (prosp.)</td>
<td>5 y 37 m†</td>
<td>Descript.</td>
<td>ESR, CRP, PV</td>
<td>180</td>
<td>138 (77)</td>
<td>180 (100)</td>
<td>Duration GC therapy</td>
</tr>
<tr>
<td>1996 Caplanne³⁴</td>
<td>14 Obs. (prosp.)</td>
<td>NR NR</td>
<td>Bird</td>
<td>Sex</td>
<td>20</td>
<td>15 (75)</td>
<td>20 (100)</td>
<td>Relapse (varT)</td>
</tr>
<tr>
<td>2006 Ceccato³⁵</td>
<td>17 Case-control (retro.)</td>
<td>13 y 40 m†</td>
<td>Chuang</td>
<td>Arthritis, ESR</td>
<td>74</td>
<td>56 (76)</td>
<td>74 (100)</td>
<td>GC-sides (varT)</td>
</tr>
<tr>
<td>1994 Cimmino³⁶</td>
<td>14 Obs. (prosp.)</td>
<td>NR 19 m¹</td>
<td>Jones &amp; Hazleman</td>
<td>Sex</td>
<td>40</td>
<td>24 (60)</td>
<td>38 (95)</td>
<td>GC-sides (varT)</td>
</tr>
<tr>
<td>2006 Cimmino³⁷</td>
<td>14 Obs. (prosp.)</td>
<td>NR 15 m¹</td>
<td>Chuang</td>
<td>Sex</td>
<td>80</td>
<td>52 (65)</td>
<td>80 (100)</td>
<td>Number of relapses (varT), Cumul GC (varT), GC-sides (varT)</td>
</tr>
<tr>
<td>2011 Cimmino³⁸</td>
<td>14 Obs. (prosp.)</td>
<td>18 m 6 m</td>
<td>Bird</td>
<td>Sex</td>
<td>60</td>
<td>35 (58)</td>
<td>60 (100)</td>
<td>Response (1 m), Remission on and off therapy (1 y)</td>
</tr>
<tr>
<td>1997 Dolan³⁹</td>
<td>14 Obs. (prosp.)</td>
<td>NR 96 w</td>
<td>Jones</td>
<td>Sex</td>
<td>50</td>
<td>36 (72)</td>
<td>50 (100)</td>
<td>Disc GC (2 y)</td>
</tr>
<tr>
<td>2013 Do-Nguyen⁴⁰</td>
<td>13 Case-control (retro.)</td>
<td>11 y 1 y†</td>
<td>NR</td>
<td>Age</td>
<td>100</td>
<td>71 (71)</td>
<td>100 (100)</td>
<td>GC-sides (varT)</td>
</tr>
<tr>
<td>1997 Gonzalez-Gay⁴¹</td>
<td>15 Case-control (retro.)</td>
<td>NR 27/32 m†</td>
<td>Descript.</td>
<td>ESR</td>
<td>201</td>
<td>121 (60)</td>
<td>191 (95)</td>
<td>Duration GC therapy</td>
</tr>
<tr>
<td>1999 Gonzalez-Gay⁴²</td>
<td>14 Case-control (retro.)</td>
<td>≥12 m</td>
<td>Descript.</td>
<td>Sex</td>
<td>134</td>
<td>85 (63)</td>
<td>NR</td>
<td>Relapse (varT)</td>
</tr>
<tr>
<td>2001 Gran⁴³</td>
<td>14 Case-control (retro.)</td>
<td>11 y 64 m¹</td>
<td>Bird</td>
<td>Sex</td>
<td>274</td>
<td>183 (67)</td>
<td>NR</td>
<td>Mortality (varT)</td>
</tr>
<tr>
<td>1996 Helfgott⁴⁴</td>
<td>15 Case-control (retro.)</td>
<td>5 y NR</td>
<td>Jones</td>
<td>ESR</td>
<td>117</td>
<td>89 (76)</td>
<td>117 (100)</td>
<td>Time to response</td>
</tr>
<tr>
<td>2007 Hutchings⁴⁵</td>
<td>15 Obs. (prosp.)</td>
<td>2 y 12 m</td>
<td>Jones</td>
<td>ESR</td>
<td>129</td>
<td>77 (60)</td>
<td>122 (95)</td>
<td>HAQ (12 m), SF36-PCS/MCS (12 m)</td>
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<tr>
<td>1986 Kanemaru⁴⁶</td>
<td>14 Case-control (retro.)</td>
<td>9 y NR</td>
<td>Hamrin</td>
<td>Sex</td>
<td>6</td>
<td>3 (50)</td>
<td>6 (100)</td>
<td>Relapse (varT)</td>
</tr>
<tr>
<td>1997 Kanik⁴⁷</td>
<td>14 Case-control (retro.)</td>
<td>33–38 m†</td>
<td>Descript.</td>
<td>Sex, ESR</td>
<td>20</td>
<td>16 (80)</td>
<td>20 (100)</td>
<td>Disc GC (varT)</td>
</tr>
<tr>
<td>2012 Kim⁴⁸</td>
<td>17 Case-control (retro.)</td>
<td>28 m†</td>
<td>Bird</td>
<td>Arthritis</td>
<td>51</td>
<td>36 (71)</td>
<td>41 (80)</td>
<td>Remission (varT)</td>
</tr>
<tr>
<td>2012 Kimura⁴⁹</td>
<td>17 Case-control (retro.)</td>
<td>10 y 26 m†</td>
<td>Hunder</td>
<td>RS3PE</td>
<td>151</td>
<td>78 (52)</td>
<td>136 (90)</td>
<td>Relapse (varT), GC-sides (varT), duration GC therapy</td>
</tr>
<tr>
<td>2005 Kremers⁵⁰</td>
<td>13 Case-control (retro.)</td>
<td>30 y 5 y†</td>
<td>Descript.</td>
<td>Age, Sex</td>
<td>364</td>
<td>244 (67)</td>
<td>163* (100)</td>
<td>Hazard 1st relapse</td>
</tr>
<tr>
<td>2005 Kremers⁵¹</td>
<td>13 Case-control (retro.)</td>
<td>30 y 5 y†</td>
<td>Descript.</td>
<td>Age, Sex</td>
<td>364</td>
<td>244 (67)</td>
<td>364 (100)</td>
<td>HealthC (6 m, ever), HealthC (1 m, 6 m, ever)</td>
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Continued
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<tr>
<th>Study ID</th>
<th>PICO Design</th>
<th>Dur.</th>
<th>Follow-up</th>
<th>PMR criteria</th>
<th>Prognostic factor</th>
<th>No pt.</th>
<th>No female (%)</th>
<th>No pt. with complete follow-up (%)</th>
<th>Outcomes (time point)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000 Larrosa et al.</td>
<td>Case–control (retro.)</td>
<td>8 y</td>
<td>NR</td>
<td>Chuang</td>
<td>ESR</td>
<td>101</td>
<td>67 (66)</td>
<td>97 (96)</td>
<td>Relapse (varT)</td>
</tr>
<tr>
<td>2013 Lee et al.</td>
<td>Case–control (retro.)</td>
<td>NR</td>
<td>114 w†</td>
<td>Bird</td>
<td>Sex</td>
<td>39</td>
<td>28 (72)</td>
<td>39 (100)</td>
<td>Relapse (varT)</td>
</tr>
<tr>
<td>2010 Mackie et al.</td>
<td>Obs. (prosp.)</td>
<td>NR</td>
<td>5 y</td>
<td>Bird</td>
<td>Sex</td>
<td>176</td>
<td>124 (71)</td>
<td>164 (93)</td>
<td>Earlier disc GC therapy, Devel. GCA (varT)</td>
</tr>
<tr>
<td>2012 Mazzantini et al.</td>
<td>Case–control (retro.)</td>
<td>39 y</td>
<td>NR</td>
<td>Bird</td>
<td>Arthritis</td>
<td>Osteoporosis</td>
<td>222</td>
<td>154 (69)</td>
<td>NR</td>
</tr>
<tr>
<td>2010 Meyerhof et al.</td>
<td>Case–control (retro.)</td>
<td>NR</td>
<td>563 d†</td>
<td>Bird</td>
<td>ESR</td>
<td>Fast taper</td>
<td>22</td>
<td>15 (68)</td>
<td>14 (64)</td>
</tr>
<tr>
<td>2001 Myklebust et al.</td>
<td>Case–control (retro.)</td>
<td>8 y</td>
<td>NR</td>
<td>Bird</td>
<td>ESR</td>
<td>199</td>
<td>160 (80)</td>
<td>180 (91)</td>
<td>Disc GC (1, 2 y)</td>
</tr>
<tr>
<td>2000 Nagaoka et al.</td>
<td>Case–control (retro.)</td>
<td>12 y</td>
<td>5 y</td>
<td>Bird</td>
<td>Sex</td>
<td>20</td>
<td>10 (50)</td>
<td>18 (90)</td>
<td>Relapse (varT)</td>
</tr>
<tr>
<td>1971 Paulsen et al.</td>
<td>Case–control (retro.)</td>
<td>NR</td>
<td>41 m†</td>
<td>NR</td>
<td>Age</td>
<td>16</td>
<td>14 (88)</td>
<td>16 (100)</td>
<td>Relapse (varT)</td>
</tr>
<tr>
<td>1999 Prickard et al.</td>
<td>Case–control (retro.)</td>
<td>13 y</td>
<td>NR</td>
<td>Descript.</td>
<td>Sex</td>
<td>49</td>
<td>40 (82)</td>
<td>37 (76)</td>
<td>Remission (2 y), Osteoporosis (varT), diabetes (varT), weight gain (varT), cataract (varT), moon face (varT), gastric complications (varT)</td>
</tr>
<tr>
<td>1999 Proven et al.</td>
<td>Case–control (retro.)</td>
<td>21</td>
<td>5–7 y†</td>
<td>Descript.</td>
<td>ESR</td>
<td>232</td>
<td>163 (70)</td>
<td>232 (100)</td>
<td>Remission (varT), relapse (varT)</td>
</tr>
<tr>
<td>1998 Salvarani et al.</td>
<td>Obs. (prosp.)</td>
<td>5 y</td>
<td>25–41 m†</td>
<td>Healey</td>
<td>Arthritis</td>
<td>RSPE</td>
<td>177</td>
<td>117 (66)</td>
<td>177 (100)</td>
</tr>
<tr>
<td>1999 Salvarani et al.</td>
<td>Obs. (prosp.)</td>
<td>NR</td>
<td>44 m†</td>
<td>Descript.</td>
<td>ESR</td>
<td>92</td>
<td>69 (75)</td>
<td>91 (99)</td>
<td>Remission (varT)</td>
</tr>
<tr>
<td>2005 Salvarani et al.</td>
<td>Obs. (prosp.)</td>
<td>4 y</td>
<td>35 m†</td>
<td>Descript.</td>
<td>Sex</td>
<td>94</td>
<td>70 (75)</td>
<td>94 (100)</td>
<td>Relapse (varT)</td>
</tr>
<tr>
<td>1995 Schaufelberger et al.</td>
<td>Case–control (retro.)</td>
<td>4 y</td>
<td>36 m†</td>
<td>Descript.</td>
<td>Sex</td>
<td>222</td>
<td>158 (71)</td>
<td>222 (100)</td>
<td>Mortality (varT)</td>
</tr>
<tr>
<td>1995 Schreiber et al.</td>
<td>Obs. (prosp.)</td>
<td>NR</td>
<td>38 m†</td>
<td>Descript.</td>
<td>Normal CRP within 1 week</td>
<td>20</td>
<td>11 (55)</td>
<td>12–7 (60–35)</td>
<td>Disc GC (2, 3, 4, 5 y), GC-sides (varT)</td>
</tr>
</tbody>
</table>

Articles containing both, data on interventions and prognostic factors are marked in bold letters.

Studies are listed in alphabetical order; †mean, ‡median; #, & or ¥ multiple papers on partially the same cohort; *patients with first relapse analysed; †mean, ‡median; °number of patients with complete follow-up data depends on the outcome, °number of patients as reported in the study of Dasgupta et al.

Case–control (retro.), Case–control study with retrospective design; Control, control treatment; CRP, C-reactive protein; Cumul, cumulative; d, days; Descript., description of symptoms and laboratory criteria defining PMR (no formal criteria used); Devel. GCA, development of giant cell arteritis during follow-up; Disc, discontinuation; dur., total duration of study; ESR, erythrocyte sedimentation rate; Follow-up, length of follow-up; GC, glucocorticoid; GC-sides, glucocorticoid-related side effects; HAQ, Health Assessment Questionnaire; HealthC, healthcare resource use; inc., increased; m, months; MCS, mental component summary score; Mul., multicenter; No pt., number of patients; NO, number of; NR, not reported; NSAIDs, non-steroidal anti-inflammatory drugs; Obs. (prosp.), observational prospective follow-up; Outcome (time points), outcomes (out of the list of critical outcomes listed in online supplementary table 51) dealt with in the corresponding study and the time points at which the outcome was investigated in parentheses; PCS, physical component summary score; PICO, Population, Intervention, Comparator, Outcome (number of PICO question); PMR, polymyalgia rheumatica; R, randomised; RSPE, remitting seronegative symmetrical synovitis with pitting oedema; SF-36, short form 36 questionnaire; stiff, stiffness; Study ID, study identifier; sympt. Dur., symptom duration; varT, variable time point/no exact date reported; w, weeks; y, years.
demonstrating that a longer duration of morning stiffness at baseline was linked with worse function and quality of life at 12 months.4 6

Presence versus absence of peripheral arthritis (PICO 17)
The prognostic value of peripheral arthritis was investigated by seven studies (n=645, LoB 2–6/8).24 35 38 45 46 55 57 The presence of peripheral arthritis was associated with a higher risk of relapse according to one study (n=177, LoB 3/8),55 whereas three studies (n=207, LoB 5–6/8) did not confirm this observation.24 35 55

Longer versus shorter symptom duration (PICO 18)
A single study (n=100, LoB 3/8) examined the prognostic impact of symptom duration before PMR diagnosis, reporting no association of this factor with later remission.19

Presence versus absence of conditions exaggerated by PMR and/or glucocorticoid therapy (PICO 19)
Two studies (n=273, LoB 2–4/8) investigated the prognostic impact of a total set of four concomitant conditions (depression, osteoporosis, diabetes and dyslipidaemia), reporting no significant results.45 49

Rapid versus delayed response to glucocorticoids (PICO 20)
A rapid response to GC therapy was dealt with by five studies (n=237, LoB 2–6/8).4 18 38 50 59 A rapid decline of C-reactive protein was associated with a lower risk of GC side effects in a single low-quality study,59 whereas treatment response was irrelevant for remission and relapse rates and for duration of GC therapy.4 18 38 50 59

DISSCUSSION
One of our most intriguing observations is that fundamental treatment principles of PMR such as initial GC doses, tapering schedules and duration of treatment have not been examined by high-quality trials thus far. In contrast, we found moderate to good evidence that MTX is of benefit for patients with a new diagnosis of PMR.10 15 27 29 Interestingly, it is clinical practice to prescribe MTX to patients with GC-resistant disease, although this approach is not supported by published evidence.2 3 The clinical value of other conventional disease-modifying antirheumatic drugs for treatment of PMR is still unclear.

The MTX dose used in PMR trials was lower than the dose normally used in other rheumatic diseases (particularly rheumatoid arthritis),60 and it is difficult to compare the relative efficacy of MTX between PMR and other conditions, because outcome parameters are disease specific, and disease course and concomitant treatments vary across diseases.62 Whether higher MTX doses are more effective but still safe for treatment of PMR has to be clarified by future studies.62

For biological agents, evidence suggests that tumour necrosis factor α blocking agents are not effective in PMR, thus contrasting the promising results of earlier small case series.63–66 Tocilizumab, used in a few cases thus far,67–68 is currently being studied in a phase 2 trial (clinicaltrials.gov NCT01396317) and results of a study comparing secukinumab, canakinumab and GCs (clinicaltrials.gov NCT01364389) will be available soon.

The evidence supporting the value of prognostic factors is only fair to moderate because of methodological limitations of most studies and because the associations were not consistently reported by all authors. A single study, for example, showed a higher relapse rate in women than in men,37 whereas eight other studies found no such association.18 20 24 34 41 51 52 57 On the other hand, women appeared to have a longer duration of treatment,14 32 higher cumulative GC doses37 and more GC-related side effects.31 36 37 Whether female patients benefit from a closer (than standard) clinical monitoring, a lower initial GC dose and a lower threshold for using MTX has to be clarified by future clinical studies.

We found one earlier systematic literature review on interventions in PMR reporting similar conclusions to our report for initial GC doses, IM methylprednisolone and the value of MTX.69 That review, however, was limited by a less comprehensive literature search than carried out in our study (eg, Embase was not searched, non-English articles were excluded), by a lack of a priori formulated key questions and outcomes, as well as by the inclusion of studies analysing patients with GCA and PMR as a single group.69 Additionally, the authors used the Jadad scale for quality appraisal, although this method has explicitly been discouraged for systematic literature reviews.70 71

In summary, moderate- to high-quality data support the use of IM GCs and MTX as GC sparing agents in PMR, whereas several treatment aspects such as initial GC doses and tapering regimen have not, or only inadequately, been investigated. Female sex, high ESR and the presence of peripheral arthritis were associated with a worse prognosis of PMR; however, a number of studies also failed to prove these associations.

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REFERENCES


Current evidence for therapeutic interventions and prognostic factors in polymyalgia rheumatica: a systematic literature review informing the 2015 European League Against Rheumatism/American College of Rheumatology recommendations for the management of polymyalgia rheumatica

Christian Dejaco, Yogesh P Singh, Pablo Perel, Andrew Hutchings, Dario Camellino, Sarah Mackie, Eric L Matteson and Bhaskar Dasgupta

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