Choosing wisely in daily practice: a mixed methods study on determinants of antinuclear antibody testing by rheumatologists

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Objectives: To explore the relationship between antinuclear antibody (ANA) overuse and rheumatologist-related factors before and after an intervention aimed at reducing ANA overuse.

Method: In this mixed methods study we performed surveys among rheumatologists (n = 20) before and after the ANA intervention (education and feedback). We identified clinician-related determinants of ANA overuse (demographic characteristics, cognitive bias, numeracy, personality, thinking styles, and knowledge) by multivariate analysis. Two focus group meetings with rheumatologists were held 6 months after the intervention to explore self-reported determinants.

Results: Questionnaires were completed by all rheumatologists and eight participated in the focus groups. Rheumatologists with more work experience and a less extravert personality ordered more ANA tests before the intervention ($\beta = 0.01$, 95% confidence interval (CI) 0.003 to 0.02, $p = 0.01$ and $\beta = -0.11$, 95% CI -0.21 to -0.01, $p = 0.04$, respectively; $R^2 = 47\%$). After the intervention, female rheumatologists changed less than their male colleagues with regard to the number of ANA tests ordered ($\beta = 0.15$, 95% CI 0.03–0.26, $p = 0.02$; $R^2 = 25\%$). During the focus groups, seven themes were identified that influenced improvement in ANA overuse: determinants related to the intervention and the study, individual health professionals, patients, professional interactions, incentives and resources, capacity for organizational change, and social, political, and legal factors.

Conclusions: We identified several determinants that together explained a sizable part of the variance observed in the ANA outcomes at baseline and in the change in ANA outcomes afterwards. Furthermore, the focus groups yielded additional factors suggesting a complex interplay of determinants influencing rheumatologists’ ANA ordering behaviour.

Method

Study design and participants

This was a mixed methods study, combining quantitative and qualitative methods. The study was embedded in a multicentre (n = 3), pragmatic, controlled before-and-after (CBA) implementation study assessing the effect of education and feedback on ANA overuse. The implementation study took place in The Netherlands and lasted 24 months (12 month pre- and post-intervention periods) (9).

Rheumatologists working in one of the three participating hospitals (general, specialized, and academic) from the implementation study were eligible for participation in this study. Those working the full study period at a study hospital for whom individual data on ANA overuse were available could be included.

Outcome measures and data collection

ANA overuse. To cover different aspects of ANA overuse, the following four outcome measures were...
used: the ANA/new patient ratio (APR; the number of ANA tests ordered divided by the number of new patients seen at the rheumatology outpatient clinic), the percentage of positive ANA tests, the percentage of repeated ANA testing within 1 year, and the percentage of ANA-associated diseases (systemic lupus erythematosus, systemic sclerosis, polymyositis/dermatomyositis, mixed connective tissue disease, or Sjögren’s syndrome). All outcome measures were calculated at the rheumatologist level.

The ANA outcomes calculated over the pre-intervention period were used to explore baseline associations with the determinants whereas the difference between the pre- and post-intervention period outcomes (ANA outcome change scores) were used to analyse improvement in ANA use.

**Determinants of ANA overuse.** The following potential determinants for ANA overuse were assessed: age, gender, PhD degree, years of work experience, cognitive bias, personality traits, thinking styles, numeracy, and ANA knowledge (the last five questionnaires are further explained in Supplementary Table S1). These determinants were assessed at baseline using web-based questionnaires (invitations sent between March and June 2012; a reminder 2 weeks after the first invitation).

In addition, questionnaires assessing modifiable determinants (cognitive bias, numeracy, and ANA knowledge) were administered a second time, 3 months after the intervention. The difference between the baseline score and post-intervention score (determinant change score) was then used in the analyses with the ANA outcome change scores.

**Self-reported determinants of improvement in ANA overuse.** To explore self-reported determinants of improvement in ANA overuse we organized two 1.5-hour focus group sessions in the largest study centre (n = 14). Both meetings were planned after regular working hours, took place at the study hospital, and were led by a female psychologist-researcher (JV). A minimum of four and a maximum of eight participants could participate in one session. The main question during the focus group was ‘Why did you change your behaviour after the intervention?’ Both sessions were audiottaped and transcribed verbatim (see Supplementary Material S2 for a more detailed description of the method).

**Data analysis**

All analyses were performed using STATA version 13.1. Descriptive statistics are presented as percentages with the accompanying absolute numbers or as means with standard deviations.

Associations between ANA baseline or change outcomes and the determinants were analysed using multiple linear regression. The results from these analyses are reported as regression coefficients (β) with the corresponding 95% confidence interval (CI), p-value, and explained variance (R²). Before these analyses, variance, floor/ceiling effects, and co-linearity were assessed, and all determinants were tested separately with linear regression (univariate analyses).

The transcripts of the focus groups were analysed by NL and JV using thematic content analysis. The results of the qualitative analysis were discussed with the other researchers (AdB, MH, and RvV) and compared to existing frameworks on this subject (Supplementary Material S2) (10–12).

**Ethical approval**

This study was presented to the local medical ethical board (CMO region Arnhem-Nijmegen) and was exempt from ethical approval (CMO number 2015-1653). All participating hospitals approved the study and all participating rheumatologists gave their consent.

All patient data needed to calculate ANA outcomes were retrieved within the study hospitals by matching two datasets locally, after which data were anonymized and provided to the research group.

The study was registered at ClinicalTrials.gov (NCT02409251).

**Results**

**Setting and participants**

All rheumatologists (n = 29) working at the three study hospitals were eligible for participation. However, the nine rheumatologists from the university hospital had to be excluded because no data on individual ANA overuse were available. The remaining 20 rheumatologists (mean age 46.2 ± 9.3 years, 55% female, 60% PhD degree or pursuing a PhD, mean working experience 9.9 ± 9.3 years) completed all questionnaires on both time points. Eight of the rheumatologists from the specialized hospital participated in the focus groups.

**Results on ANA outcomes and determinants**

Table 1 shows descriptive results on ANA outcomes and determinants. In the multivariate regression analyses, three out of four ANA baseline outcome measures (APR, repeated ANA, and ANA-associated diagnosis) and all ANA change outcomes were associated with one or more baseline determinants (Table 2). No associations between ANA change outcomes and determinant change scores (ANA knowledge and cognitive bias) were found.
Table 1. Outcomes on ANA overuse and questionnaire scores.

| ANA overuse outcomes | Pre-intervention (baseline; n = 20) | Post-intervention (n = 20) | Change score (n = 20) |
|----------------------|-------------------------------------|---------------------------|----------------------|
| ANA/new patient ratio (APR) | 0.37 ± 0.19 | 0.12 ± 0.08 | −0.25 ± 0.14 |
| % positive ANA tests | 25.7 ± 14.6 | 24.9 ± 16.9 | −0.8 ± 16.2 |
| % repeated ANA testing within 1 year | 10.9 ± 10.4 | 1.3 ± 3.7 | −9.5 ± 9.4 |
| % ANA-associated diseases* | 7.1 ± 4.5 | 9.6 ± 10.2 | 2.5 ± 7.4 |

Questionnaire scores

|                          | Pre-intervention (n = 20) | Post-intervention (n = 20) | Change score (n = 20) |
|--------------------------|--------------------------|---------------------------|----------------------|
| Cognitive bias           | 13.0 ± 4.3               | 13.4 ± 3.9                | 0.4 ± 2.4            |
| Numeracy†                | 6.6 ± 1.0                | na                        | na                   |
| ANA knowledge            | 3.3 ± 2.3                | 5.2 ± 1.5                 | 1.9 ± 1.8            |

Personality

|              | Pre-intervention (n = 20) | Post-intervention (n = 20) | Change score (n = 20) |
|--------------|--------------------------|---------------------------|----------------------|
| Extraversion | 3.33 ± 0.72              | na                        | na                   |
| Neuroticism  | 2.80 ± 0.53              | na                        | na                   |
| Openness to experience | 3.63 ± 0.50        | na                        | na                   |
| Consciousness | 3.67 ± 0.52              | na                        | na                   |
| Agreeableness| 3.80 ± 0.31              | na                        | na                   |

Thinking styles

|              | Pre-intervention (n = 20) | Post-intervention (n = 20) | Change score (n = 20) |
|--------------|--------------------------|---------------------------|----------------------|
| Rational     | 7.70 ± 8.0               | na                        | na                   |
| Experiential | 64.6 ± 8.1               | na                        | na                   |

ANA, Antinuclear antibodies; na, not applicable.
* Systemic lupus erythematosus, systemic sclerosis, polymyositis/dermatomyositis, mixed connective tissue disease, or Sjögren’s syndrome.
† This determinant was excluded from further analysis due to marked ceiling effects.
Values given as mean ± standard deviation.

Table 2. Multivariate associations between ANA outcomes and determinants.

| ANA outcome                                           | β (95% CI) | p-value |
|-------------------------------------------------------|------------|---------|
| Associations between ANA baseline outcomes and baseline determinants |            |         |
| ANA/new patient ratio (APR)                           |            |         |
| Work experience (years)                               | 0.01 (0.003 to 0.02) | 0.01    |
| Extraversion                                          | −0.11 (−0.21 to −0.01) | 0.04    |
| Explained variance (%)                                | 47         |         |
| % of ANA-associated diagnoses                         |            |         |
| Work experience (years)                               | 0.22 (0.03 to 0.42) | 0.03    |
| Extraversion                                          | 2.67 (0.38 to 5.35) | 0.03    |
| Explained variance (%)                                | 39         |         |
| % of repeated ANA tests                               |            |         |
| Female gender                                         | −10.2 (−18.92 to −1.53) | 0.02    |
| Explained variance (%)                                | 25         |         |
| Associations between ANA change outcomes and baseline determinants |            |         |
| ABR                                                   |            |         |
| Female gender                                         | 0.15 (0.03 to 0.26) | 0.02    |
| Explained variance (%)                                | 25         |         |
| % of positive ANA tests                               |            |         |
| Female gender                                         | −16.53 (−29.93 to −3.12) | 0.02    |
| Explained variance (%)                                | 23         |         |
| % of ANA-associated diagnoses                         |            |         |
| Extraversion                                          | 6.61 (2.72 to 10.49) | < 0.01  |
| Agreeableness                                         | −15.05 (−23.99 to −6.10) | < 0.01  |
| Explained variance (%)                                | 47         |         |
| % of repeated ANA tests                               |            |         |
| Female gender                                         | 10.33 (2.78 to 17.88) | 0.01    |
| Explained variance (%)                                | 28         |         |

ANA, Antinuclear antibody; CI, confidence interval.
| Theme                | Subtheme                              | Group                                                                 | Quote                                                                                                                                                                                                 |
|---------------------|---------------------------------------|-----------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Intervention and    | Study characteristics                  | Feasibility                                                           | 'What helped me enormously was actually the first talk, in which a few things that of course I already knew became really clear. But that had simply drifted away.'                                                                 |
| study factors       | Study participation                    | Family with the research team                                          | 'An enthusiastic researcher, that has a mutually encouraging effect. And then you're more likely to adjust your behaviour than when some idiot says: shouldn't you be ordering fewer tests?'                                                                 |
|                     | Quality of the intervention            | Trust in the research team                                            |                                                                                                                                                                                                        |
|                     | Content of the intervention            | Enthusiasm of the research team                                       |                                                                                                                                                                                                        |
|                     | Recommended behaviour during the      |                                                                      |                                                                                                                                                                                                        |
|                     | intervention                           |                                                                      |                                                                                                                                                                                                        |
|                     | Research team                          |                                                                      |                                                                                                                                                                                                        |
| Individual health   | (Previous) clinical experience         | Awareness regarding the importance of clinical judgment and valid   | 'The fact that it's in actually a useless screening instrument was an extra eye-opener.'                                                                                                                  |
| professional factors| Knowledge and awareness                | reasons to order a test                                              |                                                                                                                                                                                                        |
|                     |                                      | Awareness regarding own practice and its consequences                |                                                                                                                                                                                                        |
|                     |                                      | Awareness regarding false assumptions on test properties and         | 'The fact that someone says to you, "you don't need to order those things": what a relief...'                                                                                                         |
|                     |                                      | previous behaviour                                                   |                                                                                                                                                                                                        |
|                     | Cognitions (including attitudes)       | Agreement with the proposed problem and solution                      |                                                                                                                                                                                                        |
|                     |                                      | Expected outcome                                                     |                                                                                                                                                                                                        |
|                     |                                      | Professional pride and curiosity                                      |                                                                                                                                                                                                        |
|                     |                                      | Fear of uncertainty                                                   |                                                                                                                                                                                                        |
|                     |                                      | Responsibility                                                        |                                                                                                                                                                                                        |
|                     |                                      | Changing attitudes on ANA testing                                    |                                                                                                                                                                                                        |
|                     |                                      | Nature of the new behaviour                                           |                                                                                                                                                                                                        |
|                     |                                      | Confidence in new behaviour                                           |                                                                                                                                                                                                        |
|                     | Professional behaviour                 |                                                                      |                                                                                                                                                                                                        |
| Patient factors     | Patient numbers                        |                                                                      | 'I actually found it quite a challenge and so it's become a bit of a game to order as few ANA tests as possible (...). After all, you want to be top of the class, don't you?'                                                                 |
| Professional        | Team process                           | Experience with peer to peer coaching                                  |                                                                                                                                                                                                        |
| interactions        |                                      | Atmosphere                                                            |                                                                                                                                                                                                        |
|                     |                                      | Willingness to change                                                 |                                                                                                                                                                                                        |
|                     |                                      | Peer to peer contact                                                  |                                                                                                                                                                                                        |
| Incentives and      | Financial incentives and disincentives | Healthcare costs                                                       |                                                                                                                                                                                                        |
| resources           |                                      |                                                                       | 'It's actually the continuation of a trend that has been going on for years. That we're simply taking decisions with respect to the diagnosis and treatment, based on evidence.' |
|                     | Non-financial incentives and           | Time constraints                                                       |                                                                                                                                                                                                        |
|                     | disincentives                          |                                                                       |                                                                                                                                                                                                        |
|                     | Assistance for clinicians              | Electronic Health Record as barrier                                   |                                                                                                                                                                                                        |
|                     |                                      | Electronic Health Record as aid                                       |                                                                                                                                                                                                        |
| Capacity for        | Regulations, rules, policies           | Department's personnel policy                                         | 'With all the commotion surrounding the cost of healthcare, I think we need to look critically at our ordering behaviour, that's part and parcel of it too.'                                                                 |
| organizational change|                                      | Department's care policy                                              |                                                                                                                                                                                                        |
|                     |                                      | Organization's research policy                                        |                                                                                                                                                                                                        |
| Social, political,  | Economic constraints on the healthcare | Healthcare costs                                                       |                                                                                                                                                                                                        |
| and legal factors   | budget                                |                                                                       |                                                                                                                                                                                                        |
During the focus group meetings, seven major themes were identified as being of importance to ordering fewer ANA tests after the intervention. These themes related to (i) the intervention and the study, (ii) individual health professionals, (iii) patients, (iv) professional interactions, (v) incentives and resources, (vi) capacity for organizational change, and (vii) social, political, and legal factors (Table 3). A full explanation of all the themes including quotes is provided in the Supplementary Material S2.

Discussion

This study found that baseline rheumatologist characteristics such as gender, work experience, and personality are associated with ANA outcomes before the intervention as well as a change in outcomes afterwards. Furthermore, the focus groups yielded many additional potential explanations for the observed improvement in ANA overuse after the intervention.

The main strength of this study is the use of a mixed methods design, making it possible to capture more determinants of ANA overuse than with quantitative analysis alone. Conversely, as the study sample was relatively small and the focus groups took place in only one centre, not all determinants may have been captured and our results may not be generalizable to other centres. However, many of the themes identified during the focus groups are also found in previous studies (10–12).

Although studies on determinants of ANA overuse are scarce, two reviews summarize the reasons for diagnostic test ordering in general. The relationship between female gender, work experience, and test ordering has been observed before, but so far no consistent pattern has emerged. For example, more work experience has been associated with a decrease, an increase, or no change in the number of tests ordered (11, 12).

Our study determinants were not always consistently associated with ANA outcome measures. For example, at baseline, more work experience was associated both with more ANA tests and with more ANA-associated diagnoses. However, if the principles on optimal test use are applied, we would expect more tests to lead to less related diagnoses (Bayes’ theorem). That our results are not following this principle might be caused by two rheumatologists in our sample, who have many years of work experience and also preferably see patients with systemic autoimmune diseases. Finally, three out of the seven relationships found included personality: less extravert rheumatologists ordered more ANA tests; more extravert rheumatologists had more ANA-associated diagnoses; and more extravert and less agreeable rheumatologists changed more after the intervention regarding ANA-associated diagnoses. The first two associations are in accordance with each other and follow Bayes’ theorem. The reasons behind these observations are difficult to discern, although the original descriptions of both extraversion (enthusiastic, assertive, confident) and agreeableness (altruistic, cooperative) seem to fit with the direction of the associations (13). As we are aware of only one other study on this topic that observed the same association (14), this would be an interesting direction for further research.

In addition to the questionnaires, the focus groups yielded many possible determinants that could be grouped into seven themes, matching an existing framework on this subject (10). Of note, some of the themes yielded from the focus groups seemed contradictory to the determinants assessed with the questionnaires. This inconsistency was most profound in the knowledge domain. Focus group participants stressed the importance of the knowledge that was refreshed by the intervention and the new awareness on different aspects of ANA testing. Although this seems to follow the increased scores on the ANA knowledge questionnaire after the intervention, it did not translate into any association with ANA outcomes. This observation is also known from studies on guideline adherence (11, 15).

In summary, the baseline determinants work experience, personality, and gender are associated with ANA overuse at baseline and improvement in ANA overuse after the intervention. The focus groups yielded many more potential determinants, suggesting a complex interplay of factors affecting ANA ordering behaviour. Future research could focus on quantifying the relationship between the factors mentioned in the focus group and actual behaviour. Furthermore, we hope that our results might help many more physicians to avoid conducting unnecessary tests and to choose even more wisely.

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Supporting Information
Additional Supporting Information may be found in the online version of this article.

Supplementary Table S1. Questionnaires used to measure ANA determinants.
Supplementary Material S2. Methods and results on the self-reported determinants of improvement in ANA overuse.

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