

REPORT

Results of patch testing to a corticosteroid series: A retrospective review of 1188 patients during 6 years at Mayo Clinic

Mark D. P. Davis, MD,^a Rokea A. el-Azhary, MD,^a and Sara A. Farmer, BA^b
Rochester, Minnesota

Background: Allergy to topical corticosteroids is more common than previously realized. To detect this allergy, a corticosteroid series is used for patch testing in addition to corticosteroid screens on a standard series.

Objective: We sought to review our experience with patch testing to corticosteroid series.

Methods: We conducted a retrospective study of patch testing to our corticosteroid series over 6 years (January 1, 2000-December 31, 2005).

Results: Of 1188 patients patch tested to corticosteroid series, 127 (10.69%) had allergic reaction to at least one corticosteroid; 56 reacted to multiple corticosteroids. Rates of allergic patch test reaction to 19,611 individual corticosteroids were 0.41% to 5.03%. Rates of reaction to corticosteroid groups were 1.10% to 5.72%; concomitant reactions between groups were noted. Present screens on our standard series identified 74% of those detected on the corticosteroid series; tixocortol pivalate alone detected less than 50%.

Limitations: Limitations include that this study was retrospective and the possible interobserver variation in interpretation of patch tests.

Conclusion: In patients suggested to have corticosteroid allergy, patch testing confirms allergy in 10.69%; allergy is often to multiple corticosteroids and across groups. Screens on a standard series may detect 74% of those detected on a corticosteroid series. (J Am Acad Dermatol 10.1016/j.jaad.2006.11.012.)

Numerous reports have been published in the past two decades describing allergic contact dermatitis to topical corticosteroids. Corticosteroids have been dubbed the “2005 Allergen of the Year” by the American Contact Dermatitis Society. Reports on this topic have been summarized recently by Isaksson and Bruze.¹ During the 1990s, contact allergy to topical corticosteroids became a well-recognized complication of dermatologic therapy.

Four groups or classes of topical corticosteroids have been described on the basis of their chemical structure and have been reported to be helpful in identifying potential cross-reactions.

We present our institutional experience with patch testing to our corticosteroid series over 6 years (January 1, 2000-December 31, 2005).

METHODS

We retrospectively reviewed the results of patch testing to a corticosteroid series during the 6-year study period. This study was approved by our institutional review board.

Corticosteroid series

Seventeen corticosteroids are included in our corticosteroid series, 4 of which are in our standard series (Table I). There was some variability in the number of corticosteroids to which the patients were tested: 694 patients were tested to all 17 allergens, 460 to 16 allergens, 10 to 15 allergens, 1 to 14 allergens, 20 to 13 allergens, 2 to 12 allergens, and

From the Department of Dermatology^a and the Division of Biostatistics,^b Mayo Clinic.

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Correspondence to: Mark D. P. Davis, MD, Department of Dermatology, Mayo Clinic, 200 First St SW, Rochester, MN 55905.

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Table I. Reaction rate of corticosteroid allergens

Group	Allergen	N	Positive reactions			
			No.	%	Relevant No.	%
A	Hydrocortisone acetate 1%	1186	8	0.67	8	100.00
	Prednisone 5%	1187	6	0.51	4	66.67
	Tixocortol-21-pivalate 1%	1172	59	5.03	55	93.22
B	Amcinonide 1% in ETOH 70%	1184	24	2.03	23	95.83
	Fluocinolone acetonide 1% in ETOH 70%	1172	12	1.02	11	91.67
	Fluocinonide 1%	1179	12	1.02	12	100.00
	Halcinonide 1%	1187	5	0.42	5	100.00
	Triamcinolone acetonide 1%	1176	9	0.77	8	88.89
	Budesonide 0.1%	1172	36	3.07	36	100.00
C	Dexamethasone 21-phosphate disodium salt 1%	1177	11	0.93	10	90.91
	Desoximetasone 0.05%	727	3	0.41	3	100.00
D	Betamethasone 17-valerate 1%	1185	17	1.43	16	94.12
	Alclometasone 17,21-dipropionate 1%	1187	11	0.93	11	100.00
D1	Clobetasol-17-propionate 1%	1178	17	1.44	17	100.00
	Betamethasone dipropionate 0.5% in ETOH 70%	1185	16	1.35	15	93.75
	Mometasone furoate (Elocon ointment) 0.1%	1186	13	1.10	12	92.31
D2	Hydrocortisone 17-butyrate 1% alcohol	1171	25	2.13	24	96.00

ETOH, Ethyl alcohol.

1 to only 5 allergens. Desoximetasone 0.05% was not part of the corticosteroid series until March 2002, which is why some patients were tested only to 16 allergens. For the purposes of analysis, each topical corticosteroid was assigned to a group (A-D), as previously described.¹⁻³

Patients

Patients who underwent patch testing to the corticosteroid series for suggested allergic contact dermatitis to corticosteroids from January 1, 2000, to December 31, 2005, were identified from a clinical database and medical records. Patients generally were not patch tested if they had been applying topical corticosteroids to the area of the back that was being used for patch testing, took immunosuppressive drugs (including oral corticosteroids), or had medical conditions that could compromise the evaluation of skin responsiveness. In addition, patients who had denied research authorization were excluded from the analysis.

Interpretation of patch test reactions

The method of patch test application, chambers used, and reading times was the same as that used by the North American Contact Dermatitis Group (NACDG).^{4,5} Testing was conducted with Finn

Chambers (Epitest Ltd, Tuusula, Finland) on Scanpor tape (Norgesplaster Aksjeselskap, Vennesia, Norway), and patches were applied to the upper aspect of backs of patients and removed after 48 hours. The majority of allergens were purchased from Chemo-technique Diagnostics AB (Malmö, Sweden). The other allergens were compounded by our pharmacy. Reactions were evaluated initially at 48 to 72 hours and again at 96 to 168 hours after patch application. Patch test reactions were interpreted using criteria similar to the NACDG criteria: negative reaction, macular erythema, weak reaction (nonvesicular erythema, infiltration, and possibly papules), strong reaction (edematous or vesicular), extreme reaction (spreading, bullous, ulcerative lesions), and irritant reaction.^{4,5} An irritant reaction was defined as a reaction that diminished between the first and second evaluations. Reactions were further interpreted as relevant or irrelevant on the basis of a history of known contact of the affected skin areas with substances containing the allergen or a history of circumstances of likely contact with substances containing the allergen. For the purposes of this study, a positive allergic patch test result was defined as a weak, strong, or extreme reaction, including relevant macular erythema reactions after exclusion of irritant reactions.^{4,5}

Statistical analysis

Patient data were entered into a clinical database (the database clinical server is written in Uniface [Compuware Corp, Detroit, Mich] and the database in Sybase [Sybase, Inc, Dublin, Calif]). All statistical analyses were performed with the a software package (Statistical Analysis System, SAS Institute Inc, Cary, NC).

RESULTS

During the 6-year study period, 1188 patients (65% female) suggested to have allergic contact dermatitis to corticosteroids were patch tested to a corticosteroid patch test series. The mean age of the study group was 57.59 ± 16.86 years (median, 59.46; range, 13.74-93.95). Of note, the screening series we use for corticosteroids (17 allergens) is much larger than that marketed by Chemotechnique and larger than that of many other published series. A total of 19,611 allergens were tested, of which 159 were irritant reactions.

In all, 127 patients (10.69%) had an allergic reaction to at least one corticosteroid. Among the 1188 patients, 71 (5.98%) reacted to 1 corticosteroid, 28 (2.36%) to 2 corticosteroids, 6 (0.51%) to 3 corticosteroids, 6 (0.51%) to 4 corticosteroids, and 16 (1.35%) to more than 4 corticosteroids.

Overall, there were 284 allergic patch test reactions to the 19,611 corticosteroid allergens placed (1.45%), and 159 irritant patch test reactions (0.81%). The rates of allergic patch test reaction to the individual topical corticosteroids varied from 0.41% (desoximetasone 0.05%) to 5.03% (tixocortol-21-pivalate 1%) (Table I). Almost all reactions were thought to be relevant. Reaction rates for each corticosteroid group are summarized in Table II and Fig 1. The rates of allergic patch test reaction to the corticosteroid groups varied from 5.72% for group A, to 4.80% for groups B and D (D1 and D2 combined), to 1.10% for group C. Reaction rates were higher for D1 (3.54%) than for D2 (2.13%). Many cross-reactions between the corticosteroid groups were noted. Markers were not always accurate in identifying potential allergens across the whole group. Variation was noted in patch test results among the 3 Mayo sites of Rochester, Minn; Jacksonville, Fla; and Scottsdale and Phoenix, Arizona. The overall reaction rate was 1.89% for Rochester, 0.89% for Arizona, and 0.70% for Jacksonville.

Some concomitant allergic patch test reactions were observed between steroid groups. If a patient was allergic to group A, he or she had a 27.9% chance of also being allergic to group B. However, the number of observations was small and, in this example, 19 patients reacted to both groups A and

Table II. Reaction rate of corticosteroid groups

Group	N	Positive reaction*	
		No.	%
A	1188	68	5.72
B	1188	57	4.80
C	1177	13	1.10
D1	1188	42	3.54
D2	1171	25	2.13
D1/D2†	1188	57	4.80

*Percentage positive to at least one allergen in the group.

†Allergens in groups D1 and D2.

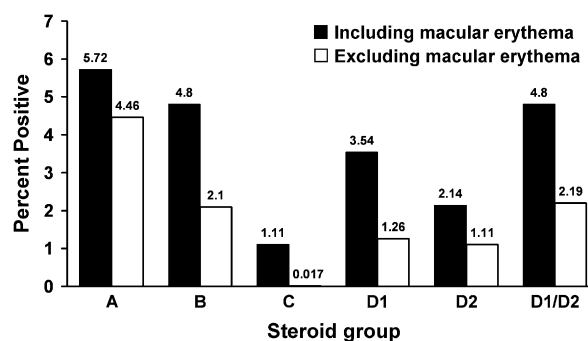


Fig 1. Reaction rates of corticosteroid groups.

B. The confidence interval was wide (17.7-40.1). In addition, if a patient was allergic to group C, he or she had an 84.6% chance of being allergic to group D1. However, if the patient had no reaction to group C, the chance of being allergic to group D1 was only 2.7%.

Table III compares the marker of a given corticosteroid group with other allergens within that group. Although the markers identify many of the reactions in each group, quite a few are still missed by them, most notably in group D. Thus, the screens used for each group (group A, tixocortol-21-pivalate 1%; group B, triamcinolone acetone 1% and budesonide 0.1%; and group D, hydrocortisone 17-butyrate 1% alcohol) identify 74% of allergies detected if the full corticosteroid series is tested; the other 26% are missed. Tixocortol-21-pivalate would identify only 48% of the reactions detected by the entire series. However, tixocortol-21-pivalate plus budesonide detects 68% of the reactions.

The screens in our standard series (group A, tixocortol-21-pivalate 1%; group B, triamcinolone acetone 1% and budesonide 0.1%; and group D, hydrocortisone 17-butyrate 1% alcohol) detect 93 of the 125 reactions (74%) identified with the corticosteroid series; the other 32 reactions (26%) would be missed. Of the 32 reactions that were missed, 19%

Table III. Comparison of allergens within corticosteroid groups

Group/screening allergen	Nonscreening allergen	+Screen		-Screen	
		+Nonscreen No. (%)	-Nonscreen No. (%)	+Nonscreen No. (%)	-Nonscreen No. (%)
A Tixocortol-21-pivalate 1%	Hydrocortisone acetate 1%	2 (0.2)	57 (4.9)	5 (0.4)	1106 (94.5)
	Prednisone 5%	1 (0.1)	58 (5.0)	4 (0.3)	1108 (94.6)
	Any group A nonscreening allergen	2 (0.2)	57 (4.9)	8 (0.7)	1104 (94.3)
B Triamcinolone acetonide 1%	Amcinonide 1% in ETOH 70%	5 (0.4)	4 (0.3)	19 (1.6)	1144 (97.6)
	Fluocinolone acetonide 1% in ETOH 70%	5 (0.4)	4 (0.3)	7 (0.6)	1144 (98.6)
	Fluocinonide 1%	4 (0.3)	5 (0.4)	8 (0.7)	1150 (98.5)
	Halcinonide 1%	1 (0.1)	8 (0.7)	4 (0.3)	1162 (98.9)
	Budesonide 0.1%	6 (0.5)	3 (0.3)	30 (2.6)	1133 (96.7)
	Any group B nonscreening allergen	8 (0.7)	1 (0.1)	48 (4.1)	1119 (95.2)
B Budesonide 0.1%	Amcinonide 1% in ETOH 70%	12 (1.0)	24 (2.1)	12 (1.0)	1120 (95.9)
	Fluocinolone acetonide 1% in ETOH 70%	6 (0.5)	30 (2.6)	6 (0.5)	1114 (96.4)
	Fluocinonide 1%	4 (0.3)	32 (2.8)	8 (0.7)	1119 (96.2)
	Halcinonide 1%	3 (0.3)	33 (2.8)	2 (0.2)	1133 (96.8)
	Triamcinolone acetonide 1%	6 (0.5)	30 (2.6)	3 (0.3)	1133 (96.7)
	Any group B nonscreening allergen	15 (1.3)	21 (1.8)	21 (1.8)	1115 (95.1)
D Hydrocortisone 17-butyrate 1% alcohol	Betamethasone 17-valerate 1%	5 (0.4)	20 (1.7)	12 (1.0)	1132 (96.8)
	Alclometasone 17,21-dipropionate 1%	3 (0.3)	22 (1.9)	8 (0.7)	1137 (97.2)
	Clobetasol-17-propionate 1%	4 (0.3)	20 (1.7)	13 (1.1)	1124 (96.8)
	Betamethasone dipropionate 0.5% in ETOH 70%	4 (0.3)	20 (1.7)	12 (1.0)	1132 (96.9)
	Mometasone furoate (Elocon ointment) 0.1%	3 (0.3)	21 (1.8)	10 (0.9)	1135 (97.1)
	Any group D nonscreening allergen	10 (0.9)	15 (1.3)	32 (2.7)	1114 (95.1)

ETOH, Ethyl alcohol.

were missed from group A, 53% from group B, and 69% from group D. Because group D is the most commonly missed, one wonders if a screen for group D1 should be used as a marker, such as clobetasol-17-propionate 1%. Thus, our screens used for each group in the standard series taken together detect the majority of patients (74%) who are allergic to corticosteroids.

Only 3 reactions from two patients were detected by triamcinolone acetonide that were not already identified by budesonide. However, budesonide identified 13 reactions that were missed by triamcinolone.

Fluorinated versus nonfluorinated corticosteroids

In our study, 158 of the 8214 nonfluorinated allergens tested (1.92%) were associated with an

allergic patch test reaction compared with 126 of the 11,238 fluorinated allergens (1.12%) ($P < .0001$).

DISCUSSION

A high rate of reaction to corticosteroids is reported herein, with 10.69% of the patients tested reacting to at least one corticosteroid and half of those patients reacting to more than one corticosteroid allergen. This is a higher rate than has been reported by others: in a recent summary of the literature from 1993 to 2002, rates from 0.52% (Melbourne, Australia) to 5.98% (Manchester, United Kingdom) have been reported. The largest studies were from the European Environmental and Contact Dermatitis Research Group (7238 patients [2.6%]) and Germany (10,361 patients [1.4%]); several other large studies have been reported.⁶ How can our high rate of contact allergy to corticosteroids

be explained? There are factors that may be proposed to explain this: first, this was a selected population that was specifically suggested to have corticosteroid allergy. Hence, patients were tested to the corticosteroid series (in many reports, the patients who tested were not specifically suggested to have corticosteroid allergy). Second, our series was larger than many other reported series. Third, macular erythema reactions (reactions without infiltration or papules) were included in the calculations because they were thought by the clinicians to be of relevance.

Macular erythema reactions

Fig 1 illustrates the difference in reaction rates with and without inclusion of the macular erythema reaction. Reactions to corticosteroid allergens are often macular erythema only; we interpret these as positive allergic patch test reactions.⁷ It is noteworthy that the rate of reaction is different if relevant macular erythema reactions are included or excluded from the calculations. For the purposes of our study, we considered a reaction to be a positive allergic patch test even with macular erythema if it was judged relevant by the managing physician.⁷

Demographics of patients tested

In this study, we present the results of patch testing patients to a corticosteroid tray. The demographic features of these patients are similar to those we have reported who were patch tested to a standard tray⁵ (data not shown).

Reaction rates of individual allergens and the corticosteroid groups

The rate of reactions to individual corticosteroid allergens varied from allergen to allergen, from 0.41% (desoximetasone 0.05%) to 5.03% (tixocortol-21-pivalate 1%). Overall, 1.45% of the 19,611 allergens tested produced an allergic patch test reaction. A total of 127 patients (10.69%) had an allergic reaction to at least one corticosteroid.

It appears from our data that budesonide is a better marker of group B corticosteroids than triamcinolone. We have chosen to leave triamcinolone on our standard tray because it is the most commonly used corticosteroid in our practice.

We previously reported a lower rate of reaction to tixocortol pivalate, but it did not include the macular erythema reaction rates. Tixocortol pivalate is an interesting allergen. Although it is used as an allergen marker for relevant corticosteroids in group A, it is not available in the United States and has only limited use as an inhaled corticosteroid in a few countries, particularly France. Can real relevance be assigned to an allergen to which patients have not been

exposed? Our clinicians considered the reactions to tixocortol pivalate to be relevant in most cases because of its being a marker for group A corticosteroids, but strictly, it could be argued that the relevance should be zero because patients would not have been exposed to this allergen in the United States.

Fluorinated versus nonfluorinated corticosteroids

The proportion of nonfluorinated corticosteroid allergens associated with a reaction (1.91%) was higher than that of fluorinated allergens (1.1%) ($P < .0001$). It has been reported that the rate of allergy reflects the relative usage of nonfluorinated and fluorinated products. Predominant use of nonfluorinated corticosteroids (hydrocortisone, hydrocortisone 17-butyrate, and budesonide) appears to produce a higher prevalence of corticosteroid contact allergy than fluorinated corticosteroids in England, United Kingdom⁸; although similar data are not available in the United States, it is possible that there is a similar pattern of use in the United States. As shown previously, nonfluorinated corticosteroids degrade more rapidly in an in vitro system and, thus, may be more likely to sensitize than fluorinated corticosteroids.

Geographic variation

We observed varying rates of reaction at the 3 institution sites in the prevalence of allergic contact dermatitis to topical corticosteroids. This may be attributable to multiple factors; it is possible that there is geographic variation in reactions. Others have also reported geographic differences, for example, in England, United Kingdom, Thomson et al⁸ compared the rates of reaction to corticosteroid allergens in Oxfordshire with those in Manchester and reported that the overall allergic patch test reaction rates were 1.9% and 4.3%, respectively.

Reaction rates of the corticosteroid groups

It was interesting to compare the corticosteroid reactions according to the groups outlined by Goossens et al,² who reported that the rates of reaction were highest for the A allergens and lowest for the C allergens. It is conceivable that the lower rate of reaction to group C corticosteroids is explained by the group having only a couple of screens in our corticosteroid series. It is also possible that the lower rates seen for group C results from more exposure to this group as ophthalmic, intranasal, or oral preparations of the group C corticosteroids. These routes of exposure may result in tolerance. Nonetheless, our data suggest that the group C corticosteroids have the lowest rate of allergenicity.

Reaction rates between the corticosteroid groups

Some of the patients in our study were allergic to allergens in multiple groups. Cross-reaction or co-reaction occurs between groups of corticosteroids. Our data imply that the division of corticosteroid allergens into groups, although useful, cannot be relied on entirely because there can be reaction between groups. If a patient is allergic to corticosteroid allergens in one group, that patient may also react to allergens in another corticosteroid group. However, we recognize that the number of observations is small.

Taken together, the data suggest that the screens on the standard series detect a variable percentage of patients who may be allergic to corticosteroids. The 4 screens of our series detect approximately 74% of the allergies that would be picked up on the wider corticosteroid series containing 17 allergens. If the 3 screens are used, 71% of the reactions would be detected, and if 2 of the screens are used, it would be 68%. If tixocortol pivalate alone is used as a screen, then less than 50% would be detected. In accord with previous recommendations,⁹ a corticosteroid series should be tested when there is any question of corticosteroid allergy, and a patients with dermatitis should also be patch tested with the different corticosteroids used by that patient. If a patient has a positive reaction to tixocortol pivalate or budesonide (or both), then additional patch testing with a commercial corticosteroid series should be undertaken.⁹ Once a patient has reacted to a screening marker or to a separate corticosteroid, he or she should be tested with an extended corticosteroid series.⁹ It is evident that more than one marker for corticosteroid contact allergy must be used.²

The concentrations of tixocortol pivalate and budesonide to be used in patch testing to detect allergic contact dermatitis from topical corticosteroids are debated,¹⁰ as are the vehicles used. A survey of members of the British Contact Dermatitis Group reported a significantly lower rate of detection of contact allergy with a lower concentration of tixocortol pivalate and budesonide than with a higher concentration.¹⁰

Late reactions

As we have reported previously, late reactions were infrequent in our patients being patch tested to corticosteroids.¹¹ Our experience is in contrast with the reports of others that extended readings to corticosteroid are necessary to detect 30% of the reactions. From April 2001 to June 2004, we obtained additional readings at 7 days after application of corticosteroids, and 135 patients were patch tested

Table IV. Number of corticosteroid reactions (N = 1188)

No. of positive allergens	Frequency	%	Cumulative frequency	Cumulative %
0	1061	89.31	1061	89.31
1	71	5.98	1132	95.29
2	28	2.36	1160	97.64
3	6	0.51	1166	98.15
4	6	0.51	1172	98.65
5	4	0.34	1176	98.99
6	4	0.34	1180	99.33
7	3	0.25	1183	99.58
8	2	0.17	1185	99.75
9	1	0.08	1186	99.83
12	1	0.08	1187	99.92
13	1	0.08	1188	100.00

with 1656 corticosteroid allergens. Of the patients with no reactions on day 5, two had a positive reaction at the extended reading; each had a relevant reaction to budesonide 0.1%, one on day 7 and the other on day 9; the former would have been detected if macular erythema reactions had been included as an allergic patch test reaction. Thus, only two (or one) reactions (to 1656 corticosteroids) became apparent with extended reading. In our experience, extended readings are of limited value.¹⁰

Limitations in the conclusions of this study

There may be controversy with respect to the calculation of patch test reactions: we included macular erythema reactions in the calculation of allergic patch test reaction rates; however, other authors would ascertain that macular erythema without papules or infiltration is usually not considered positive patch test reactions. However, we think that these reactions are common, important, and relevant. In the current study, they accounted for almost half the reactions.⁷ We excluded reactions graded as irritant reactions; irritant reactions were defined as those reactions that diminished between the first and second evaluations. It is possible that some of the reactions interpreted as irritant were actually positive allergic patch test reactions and not irritant patch test reactions.

In general, we did not do subsequent use tests to the "relevant" corticosteroid reactions.

Furthermore, there was variability in the interpretation of reactions, and this could represent interobserver bias.

Size of our corticosteroid series compared with that of Chemotechnique series

Our corticosteroid allergen series (17 corticosteroid allergens) is larger than that of other series. The question arises of whether it is necessary to have such a large corticosteroid series. Table IV summarizes

the data with regard to this question. If only the Chemotechnique series (a series of 8 allergens) was used, 1.4% of patients with reactions would be missed, or 11.8% of positive reactions (15/127).

One allergen not included on either series is fluticasone, a class D1 corticosteroid, which has been reported to be a rare contact sensitizer.¹²

SUMMARY

The screens on the standard series (4 on our series) identify approximately 74% of corticosteroid reactions detected on a 17-panel corticosteroid series. Tixocortol pivalate alone detected less than 50% of these reactions. More than 10% of the patients who were suggested to have corticosteroid allergy and, therefore, tested to the corticosteroid series had a reaction. Relevant macular erythema reactions should be included in the calculation of allergic patch test reactions. Readings of reactions at day 7 detected only one more reaction of 135 patients. The grouping of corticosteroid allergies advocated by Goossens et al² is useful, but concomitant reactions between the groups is not uncommon. Almost half of the patients with reactions to the corticosteroids had reactions to more than one corticosteroid. Furthermore, reactions often occur across the groups.

We conclude that the use of 3 or 4 screening corticosteroid allergens detects between 68% and 74% of corticosteroid allergies. Testing to the extended corticosteroid series is appropriate when corticosteroid allergy is suggested, because it can help define the corticosteroids that a patient could use, given their allergies. Use of the corticosteroid groups, although useful, is not precise in advising patients which corticosteroid they can use.

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REFERENCES

1. Isaksson M, Bruze M. Corticosteroids. *Dermatitis* 2005;16:3-5.
2. Goossens A, Matura M, Degreef H. Reactions to corticosteroids: some new aspects regarding cross-sensitivity. *Cutis* 2000;65:43-5.
3. Lepoittevin JP, Drieghe J, Doms-Goossens A. Studies in patients with corticosteroid contact allergy: understanding cross-reactivity among different steroids. *Arch Dermatol* 1995;131:31-7.
4. Pratt MD, Belsito DV, DeLeo VA, Fowler JF Jr, Fransway AF, Maibach HI, et al. North American contact dermatitis group patch-test results, 2001-2002 study period [Erratum in: *Dermatitis* 2005;16:106]. *Dermatitis* 2004;15:176-83.
5. Wetter DA, Davis MD, Yiannias JA, Cheng JF, Connolly SM, el-Azhary RA, et al. Patch test results from the Mayo Clinic Contact Dermatitis Group, 1998-2000. *J Am Acad Dermatol* 2005;53:416-21.
6. Keegel T, Saunders H, Milne R, Sajjachareonpong P, Fletcher A, Nixon R. Topical corticosteroid allergy in an urban Australian center. *Contact Dermatitis* 2004;50:6-14.
7. Davis MDP, Yiannias JA. Should macular erythema reactions be counted as positive allergic patch-test reactions? *Dermatitis* 2006;17:12-4.
8. Thomson KF, Wilkinson SM, Powell S, Beck MH. The prevalence of corticosteroid allergy in two UK centres: prescribing implications. *Br J Dermatol* 1999;141:863-6.
9. English JS. Corticosteroid-induced contact dermatitis: a pragmatic approach. *Clin Exp Dermatol* 2000;25:261-4.
10. Wilkinson SM, Beck MH. Patch testing for corticosteroid allergy using high and low concentrations. *Contact Dermatitis* 2000;42:350-1.
11. Davis MD, Richardson DM, Farmer SA. Low yield for extended reading of patch tests with topical corticosteroids. *Dermatitis* 2005;16:124-6.
12. Goossens A, Huygens S, Matura M, Degreef H. Fluticasone propionate: a rare contact sensitizer. *Eur J Dermatol* 2001;11:29-34.