

Review Article

Textile dye allergic contact dermatitis prevalence

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This article summarizes textile dye prevalence studies and makes recommendations for advancing knowledge about textile-dye sensitization. Prevalence data is provided by study and by dye. Dermatology teams are encouraged to conduct textile-dye prevalence studies in countries other than Italy, include dyes for which the least prevalence data has been collected, to standardize method of application and reading, and to verify purity and identity of dyes used for patch testing. Testing with pure dyes and other chemicals in dye formulations should provide insights in choosing dye systems that will decrease sensitization.

Key words: allergic contact dermatitis; textile dyes; prevalence; occupational; clothing dermatitis.
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While dermatologists have reported cases of skin reactions suspected to be caused by textile dyes since 1869 (1), they have reported textile-dye prevalence results only during the last decade (2–12). This article summarizes the textile-dye prevalence studies (2–12) and makes recommendations for advancing knowledge about textile-dye sensitization.

Methods

A database was created to allow ready comparison of prevalence data by study and by specific dye. 3 tables were developed to record information about each study with records including (a) journal article designation, (b) patients tested, (c) name and origin of patch test allergens, (d) patch test details, and (e) study prevalence. In Table 1, records are placed into 2 categories based on type of patient patch tested. Table 1 contains the records of those studies in which patients appeared for routine patch testing which included textile dyes, Table 2 contains the records of those studies in which patients were suspected to have textile-dye allergic contact dermatitis (ACD), and Table 3 contains the records of those studies in which patients were known or were very likely to have textile-dye ACD.

Additionally, 2 tables were constructed to record patch test results about each dye used in testing, 1 table for disperse dyes (Table 4), and 1 for nondisperse dyes (Table 5). Each record in these tables consists of dye name, number of patch-test-positive patients in the study, number of patients who were patch tested, study code (1 for studies in Table 1, 2 for studies in Table 2, and 3 for studies in Table 3), prevalence, and reference. Dyes are arranged in order of amount of prevalence information available about them.

Findings

11 textile-dye prevalence articles were published from 1989 to 1999 (2–12) and an additional article provides data from which textile-dye prevalence can be obtained (13) (Tables 1–3). 1 article reports 4 studies (10), 1 article reports 3 studies (13), 2 articles report 2 studies each (2, 3) and the remaining 8 articles report 1 study each for a total of 19 studies. The focus of 2 articles (4,12) is on textile-dye prevalence among textile and garment manufacturing employees. The remaining 10 focus on prevalence among people without occupational exposure to dyes.

Table 1. Studies in which patients appeared for routine patch testing which included textile dyes

Ref.	Patients	Name and origin of dye allergens	Patch test details	Study prevalence
(2) Study 2	576 consecutive patients with various eczemas. No time period stated.	Disperse Dyes Blue 124, Red 1, Orange 3, and Yellow 3 and GIRDA standard series.	Al-test strips on Scanpor tape. Removed after 48 h and read 1 h and 24 h later. Removed after 48 h and read 1 h and 24 h later.	3.3% (19 of 576 – 6 men and 13 women)
(7)	569 patients aged 20 to 70 years who were referred to Italian allergological service with dermatitis suspected of being allergic in nature. No time period stated.	GIRDCA standard series (Hermal/Trolab), Textile dye series (Firma, Italy) ^{a)} , 17 nondisperse dyes directly provided by industry applied at 2% pet.	Finn Chambers on Scanpor tape to healthy back skin. Removed 2 days and read 1 day later.	1.4% (6 of 569)
(10) Study 2	861 consecutive Italian patients seen between 12/1/1988 and 11/18/1989.	GIRDCA standard series supplemented with Disperse Dyes Blue 124, Red 1, Yellow 3, Orange 3.	Finn Chambers with Scanpor tape using the Wilkinson et al. procedure.	4.8% (41 of 861)
(10) Study 3	746 Italian patients seen between 11/19/1990 and 4/30/1990.	GIRDCA standard series, 4 disperse Dyes above and 12 other dyes: Disperse dyes Red 17, Black 1, Orange 76, Yellows 9 and 54, and Blues 3 and 35, Acid Black 48, Basic Black 1, aminoazobenzene, and p-dimethylaminazobenzene.	Finn Chambers with Scanpor tape using the Wilkinson et al. procedure.	5.8% (43 of 746)
(3) Study 1	3336 contact dermatitis patients in Belgian clinic seen between 1987 and 1991.	European standard series (Hermal/Trolab) which included PPD as a textile dye indicator.	Van de Bend sq. chambers fixed with Micropore and covered with Mefix. 2 and 4 (exceptionally 3) days, following ICDRG guidelines. Excluded doubtful reactions.	0.2% (8 of the 3336 were positive to PPD)
(11)	1814 consecutive patients attending Italian patch test clinic between 2/1993 and 6/1994.	GIRDCA standard series augmented by 5 nondisperse dyes frequently used to dye natural fibers at 5% pet.: Direct Orange 34, Direct Yellow 169, Acid Yellow 61, Acid Reds 118 and 359. Origin was dye manufacturer.	Applied on back. Removal at 3 days and read 2–3 h later according to ICDRG guidelines.	0.88% (16 of 1814)
(8)	1813 consecutive patients seen between 2/93 and 6/94.	GIRDCA standard series and 12 commonly used textile reactive dyes: Reds 123, 238 and 244, Orange 107, Yellow 17, Blues 18, 21, 122 and 238, Violet 5, Black 5, Green 12. Origin was Ciba, Hoechst, and Sandoz dye manufacturers.	As powder in 5% pet. To healthy back skin with Finn chambers on Scanpor tape. Removed after 3 days and read 3h later and at 4 days. Evaluated according to ICDRG guidelines.	0.99% (18 of 1813 to reactive dyes and allergens in GIRDCA series and 4 to reactive dyes only)
(9)	312 consecutive Italian patients admitted to allergological service for suspected ACD. No time period stated.	5 reactive dyes; Reds 180 and 198, Oranges 16 and 96, and Blue 220 at 5% and 10% in pet. Origin was Hoechst dye manufacturer.	Applied to healthy back skin with Finn Chambers on Scanpor tape. Removal at 3 days and read after 3h and 4 days.	0%
(13) ^{b)} Study 1	6203 Italian patients during 1990–1995 period.	Disperse Dyes Blue 124, Orange 3, Yellow 3, and Red 1 from FIRMA ^{a)} . Purity of dyes checked with another working group.	No information provided.	3.8% (236 of 6203)
(6)	Reviewed 1012 Italian patients (311 men and 701 women) with suspected ACD. No time period stated.	GIRDCA standard series augmented by Disperse Dyes Black 1 (1% pet.) and Blue 3 (1% pet.) and a mix composed of Disperse Dyes Blue 124, Red 1, Yellow 3, and Orange 3. Patch tests with suspected fabric in cases with a history of wearing colored garments.	No information provided.	3.1% (31 of 1012 – 26 women and 5 men)

^{a)} FIRMA patch test series of 9 dyes: Disperse Reds 1 and 17; Disperse Blues 3 and 124; Disperse Orange 3; Disperse Yellows 3 and 9; Disperse Black 1, and Basic Brown 1.

^{b)} Not strictly a prevalence study, but rather a study of cross-sensitization of dyes. Included because prevalence can be obtained from the data presented.

Research methods

3 different patient populations were selected for testing with textile dyes. 10 studies were conducted by patching testing eczematous patients to determine the cause of ACD (Table 1), 3 studies were conducted by patch testing eczematous patients who were suspected to be textile-dye sensitive (Table 2), and 6 studies were conducted by patch testing eczematous patients who were or probably were textile-dye sensitive (Table 3). The objectives in the latter 2 types of studies were either to determine specific dyes to which a patient was sensitive or to determine the best set of dyes to use in routine patch testing to detect textile-dye sensitivity. Further, 15 of the 19 studies were performed in Italian clinics (4 in ref. (10), 3 in ref. (13), 2 in ref. (2) and 1 each in refs. (4, 6–9, 11). The remaining studies were done in Belgian (3), US (12), and Portuguese (5) clinics. Patients were adults except in the Goncalo (5) and Seidenari et al. investigations (13, study 2) where patients were children.

Numbers of eczematous patients who were patch tested in Table 1 studies varied from 6203 (13, Study 1) to 312 (9) and in Table 3 studies varied from 145 (2) to 23 (13, Study 2). Often sex distribution was not provided. However, when reported (2, 3, 4, 6), more women than men were in the study population.

Most of the studies included disperse and non-disperse dyes but far more disperse than nondisperse dyes were used. 3 studies focused exclusively on nondisperse dyes (8, 9, 11). Dyes for patch testing were obtained from FIRMA – Fabbrica Italiana Ritrovati Medicinali Affini – (Firenze, Italy), Hermal/Trolab (Hamburg, Germany), Chemotechnique Diagnostics (Malmö, Sweden), or directly from dye manufacturers. Usually, the dyes were not checked for identity or purity. Number of dyes used in any study varied from 27 (7) to 4 (13, study 2): in all, 18 disperse, 17 reactive, 4 acid, 4 basic, 1 direct, and 10 nondisperse dyes of unidentified application class were used.

Patch test application materials included use of Finn Chambers (Epitest, Helsinki, Finland) on Scanpor tape (Norgesplaster, Oslo, Norway), Al-test strips, and Van de Bend square chambers with Micropore (3M, St. Paul, Minn.) and covered with Mefix (Smith & Nephew). Techniques mentioned were those of Wilkinson et al. (14) and Sertoli et al. (15). Application times were either 2 days or 2 and 4 days (3 days exceptionally). Times given for interval between removal of patch to reading the skin response were 1 h and 24 h, 48 h and 72 h, 2 to 3 h, and 3 h and 4 days. Not all authors reported application method and reading procedure.

Table 2. Studies in which patients were suspected to have textile-dye ACD

Ref.	Patients	Name and origin of dye allergens	Patch test details	Study prevalence
(10) Study 1	1145 Italian patients some of whom were suspected of having textile-dye ACD seen between 10/1/1987 and 11/30/1988.	Textile industry patch test series (specific source not given).	Finn Chambers with Scanpor tape using the Wilkinson et al. procedure.	% (16 patients with positive test to dyes but unclear how many of the 1145 were patch tested with the dyes)
(3) Study 2	164 contact dermatitis patients in Belgium clinic seen between 1987 and 1991 who were suspected of having textile-dye ACD.	159 tested with 14 Chemotechnique textile dyes ^{a)} with p-aminoazobenzene (0.25% pet) added, and 5 tested with only Disperse Dyes Orange 3, Yellow 3, and Blue 106.	Same as Study 1 described in Table 1 of this article.	17.1% (28 of 164; 21 women and 7 men)
(5)	329 children 14 yrs and younger seen between 1985 and 1989 at a Portuguese clinic some of whom were suspected of having textile-dye ACD.	GPEDC (Hermal/Trolab) series ^{b)} , and additional series indicated by clinical data including the following dyes: Disperse Dyes Orange 3, Yellow 3, Red 1, and Bismarck Brown.	Read at 2 and 3 or 4 days according to ICDRG guidelines.	% (4 children with positive test to dyes but unclear how many children were patch tested with the dyes)

^{a)} Chemotechnique patch test series of 15 dyes: Disperse Reds 1 and 17; Disperse Blues 3, 35, 85, 106, 124, and 153; Disperse Oranges 1, 3, and 13; Disperse Yellows 3 and 9, Disperse Brown 1; and Basic Red 46.

^{b)} Hermal/Trolab patch test series of 5 dyes: Disperse Dyes Reds 1 and 17, Orange 3, Yellow 3, and Blue 3.

Table 3. Studies in which patients were known or most likely sensitized to textile dyes

Ref.	Patients	Name and origin of dye allergens	Patch test details	Study prevalence
(4)	104 garment-industry workers (11 men and 93 women) plus 57 textile-industry workers (42 men and 15 women) with occupational contact dermatitis seen during 1986 and 1987.	Disperse Dyes Blue 124, Yellow 3, Black 1, Orange 76, Yellow 54, Red 17, Blue 35, and Orange 3, and Acid Black 48 in 1% pet. Origin/series not stated.	Prepared haptens according to Cronin (19) and Fisher (20). Used Rapid Patch Test (RPT) technique.	31.7% ACD in garment workers 49.2% in textile workers
(2) Study 1	145 Italian patients suspected of having ACD from textile chemicals seen during 1989 and 1989.	Un-named textile series: Disperse Dyes Blue 124, Red 1, Orange 3, Yellow 3, Red 17, Orange 76; Basic Brown 1 and Acid Black 48 in 1% pet. plus the GIRDCA standard series.	Al-test strips on Scanpor tape. Re-moved after 48 h and read 1 h and 24 h later.	15.9% (23 of 145)
(10) Study 4	98 Italian patients identified as having dye allergy by patch testing with dyes described in Table 1 of this article.	4 dyes: Disperse Blue 124, Red 1, Orange 3, and Yellow 3. 9 textile dyes: Disperse Red 17, Black 1, Orange 76, Yellow 9 and 54, Blue 3 and 35; Acid Black 48, Black Base 1.	Finn Chambers with Scanpor tape using the Wilkinson et al. procedure.	72% and 63.3% (72 of 100 to at least 1 dye in the 4 dye series and 62 of 98 to at least 1 dye in the 9 dye series)
(12)	72 US/NC textile industry workers seen between 1989 and 1994 for evaluation of possible work-related contact dermatitis. Age range 19 to 62 years with average age of 44.	Standard screening series (Hermal or North American Contact Dermatitis Group series). 70% underwent testing with dye and chemical series (Chemotechnique ^{a)}). Patient specific allergens including individual dyed fabrics.	Finn Chamber method. North American Contact Dermatitis group grading scheme.	6.9% (5 of 72)
(13) Study 2	23 children identified as being azo-dye sensitive by patch testing with dyes described in Table 1 of this article.	Disperse Dyes Red 1, Orange 3, Yellow 3, and Blue 124.	See Seidenari et al. 1997, Study 1, Table 1 of this article.	100%? (23 of 23?)
(13) Study 3	33 patients identified as being dye sensitive by patch testing with dyes described in Table 1 of this article.	Disperse Dyes Orange 76, Blue 3, Red 17, Black 1, Yellow 54, Yellow?, Blue 35 and Basic Brown?	See Seidenari et al. 1997, Study 1, Table 1 of this article.	72.7% (24 of 33)

^{a)} Chemotechnique patch test series of 15 dyes: Disperse Reds 1 and 17; Disperse Blues 3, 35, 85, 106, 124, and 153; Disperse Oranges 1, 3, and 13; Disperse Yellows 3 and 9, Disperse Brown 1; and Basic Red 46.

Table 4. Prevalence of each disperse dye by study

Dye	#+s	#. Patients	Study category ^{a)}	Prevalence	Ref. – Study
Disperse Orange 3	5	576	1	0.8%	2 – 2
	1	569	1	0.2%	7
	107	6203	1	1.7%	13 – 1
	5	164	2	3.0%	3 – 2
	6	145	3	4.1%	2 – 1
	2	72	3	2.8%	12
	28	100	3	28.0%	10 – 4
	12	23	3	52.2%	13 – 2
	1	62	3	1.6%	4
Disperse Yellow 3	42	6203	1	0.7%	13 – 1
	8	1012	1	0.8%	6
	3	576	1	0.5%	2 – 2
	1	164	2	0.6%	3 – 2
	5	145	3	3.4%	2 – 1
	24	100	3	24.0%	10 – 4
	4	23	3	17.4%	13 – 2
	1	72	3	1.4%	12
	4	62	3	6.5%	4
Disperse Red 1	67	6203	1	1.1%	13 – 1
	6	576	1	1.0%	2 – 2
	5	1012	1	0.5%	6
	2	159	2	1.3%	3 – 2
	7	145	3	4.8%	2 – 1
	14	23	3	60.9%	13 – 2
	29	100	3	29.0%	10 – 4
	1	72	3	1.4%	12
Disperse Blue 124	11	576	1	1.9%	2 – 2
	104	6203	1	1.7%	13 – 1
	22	1012	1	2.2%	6
	6	159	2	3.8%	3 – 2
	12	145	3	8.3%	2 – 1
	1	72	3	1.4%	12
	36	100	3	36.0%	10 – 4
	4	23	3	17.4%	13 – 2
	8	62	3	12.9%	4
Disperse Red 17	5	159	2	3.1%	3 – 2
	3	145	3	2.1%	2 – 1
	20	98	3	20.4%	10 – 4
	3	33	3	9.1%	13 – 3
	1	62	3	1.6%	4
Disperse Blue 35	6	159	2	3.8%	3 – 2
	2	145	3	1.4%	2 – 1
	5	98	3	5.1%	10 – 4
	1	33	3	3.0%	13 – 3
	1	62	3	1.6%	4
Disperse Orange 76	3	145	3	2.1%	2 – 1
	11	98	3	11.2%	10 – 4
	12	33	3	36.4%	13 – 3
	2	62	3	3.2%	4
Disperse Black 1	1	569	1	0.2%	7
	12	98	3	12.2%	10 – 4
	3	33	3	9.1%	13 – 3
	2	62	3	3.2%	4
Disperse Yellow 54	3	98	3	3.1%	10 – 4
	2	33	3	6.1%	13 – 3
	1	62	3	1.6%	4
Disperse Blue 3	0	159	2	0.0%	3 – 2
	4	98	3	4.1%	10 – 4
	5	33	3	15.2%	13 – 3
Disperse Yellow 9	2	159	2	1.3%	3 – 2
	11	98	3	11.2%	10 – 4
Disperse Orange 1	5	159	2	3.1%	3 – 2
Disperse Orange 13	2	159	2	1.3%	3 – 2
Disperse Yellow?	2	33	3	6.1%	13 – 3
Disperse Blue 85	1	159	2	0.6%	3 – 2
Disperse Blue 106	16	159	2	9.8%	3 – 2
Disperse Blue 153	3	159	2	1.9%	3 – 2
Disperse Brown 1	4	159	2	2.5%	3 – 2

^{a)} 1 refers to studies recorded in Table 1, 2 refers to studies recorded in Table 2, and 3 refers to studies recorded in Table 3.

Table 5. Prevalence of each nondisperse dye by study

Dye	#+s	#. Patients	Study category ^{a)}	Prevalence	Ref. – Study
Acid Black 48	1	569	1	0.2%	7
	1	62	3	1.6%	4
	3	145	3	2.1%	2 – 1
	4	98	3	4.1%	10 – 4
Basic Red 46	1	569	1	0.2%	7
	1	159	2	0.6%	3 – 2
	2	72	3	2.8%	12
Basic Brown 1	1	159	2	0.6%	3 – 2
	2	145	3	1.4%	2 – 1
Acid Yellow 61	1	569	1	0.2%	7
	5	1814	1	0.3%	11
Acid Red 118	1	569	1	0.2%	7
	1	1814	1	<0.1%	11
Acid Red 359	1	569	1	0.2%	7
	2	1814	1	0.1%	11
Basic Black 1	9	100	3	9.2%	10 – 4
Basic Brown?	1	33	3	3.0%	13 – 3
Direct Orange 34	8	1814	1	0.4%	11
Direct Yellow 169	0	1814	1	0.0%	11
Reactive Red 123	1	1813	1	<0.1%	8
Reactive Red 180	0	312	1	0.0%	9
Reactive Red 198	0	1813	1	0.0%	9
Reactive Red 238	1	1813	1	<0.1%	8
Reactive Red 244	1	1813	1	<0.1%	8
Reactive Orange 16	0	312	1	0.0%	9
Reactive Orange 96	0	312	1	0.0%	9
Reactive Orange 107	2	1813	1	<0.1%	8
Reactive Yellow 17	1	1813	1	<0.1%	8
Reactive Green 12	0	1813	1	0.0%	8
Reactive Blue 18	0	1813	1	0.0%	8
Reactive Blue 21	1	1813	1	<0.1%	8
Reactive Blue 122	3	1813	1	0.2%	8
Reactive Blue 220	0	312	1	0.0%	9
Reactive Blue 238	2	1813	1	<0.1%	8
Reactive Violet 5	5	1813	1	0.3%	8
Reactive Black 5	2	1813	1	<0.1%	8
Yorkshire Red	0	569	1	0.0%	7
Yorkshire Joracril Yellow	0	569	1	0.0%	7
Yorkshire Joracril Blue	0	569	1	0.0%	7
Sandolan Blue	0	569	1	0.0%	7
Diazol Black	0	569	1	0.0%	7
Brilliant Red	0	569	1	0.0%	7
Marine Foron Blue	0	569	1	0.0%	7
Supramine Blue	0	569	1	0.0%	7
Astrazon MS Green	0	569	1	0.0%	7
Astrazon M Green	0	569	1	0.0%	7

^{a)} 1 refers to studies recorded in Table 1, 2 refers to studies recorded in Table 2, and 3 refers to studies recorded in Table 3.

Study prevalence

In those studies in which patients appeared for routine patch testing and disperse dyes were included (2, 7, 10, 13, and 6 in Table 1), prevalence values range from 5.8% (10, study 3) to 1.4% (7). In those Table 1 studies in which only nondisperse dyes were used for patch testing (8, 9, 11), prevalence values range from 1.0% to 0.0%. Only 1 prevalence value could be calculated from the information provided in those

studies in which patients suspected of having textile-dye ACD were tested with a series of textile dyes (Table 2 studies). That prevalence was 17.1%. Prevalence values in patient populations known or most likely sensitized to dyes ranged from 72.7% to 15.9%.

Prevalence for women appears to be higher than for men. Specifically, in Balato et al. (2, study 2, Table 1), 13 women and 6 men were patch test positive to at least 1 dye, in Dooms-Goossens (3, study 2, Table 2), 21 women and 7 men were patch

test positive, and in Lodi et al. (6, Table 1), 26 women and 5 men were patch test positive. The % of patch-test-positive subjects who were women in each study is, therefore, 75%, 83%, and 68%, respectively. Whether women are more susceptible to sensitization by textile dyes is not known as these %s may be a reflection of the proportion of men to women in the study patient population and not necessarily reflective of the total population. The only data available to compare the proportion of women patch test positive to the proportion in the study population is that of Lodi et al. (6); there were 701 women and 311 men making the proportion of females 69.3%. This proportion approximates the proportion of women patch test positive to at least 1 dye (68%).

Disperse dye prevalence

The amount of prevalence data collected for various disperse dyes varies considerably (Table 4) with the greatest amount being available for Disperse Dyes Orange 3, Yellow 3, Red 1, and Blue 124. For these 4 dyes, patch testing has occurred in all 3 study categories or patient population types (1, 2, and 3). For these 4 dyes the highest prevalence value in the Study 1 category is 2.2% in 1 of the Disperse Blue 124 studies and 0.2% in 1 of the Disperse Orange 3 studies. Average prevalence values calculated for these 4 dyes using the Study 1 data are 2.4% for Disperse Blue 124, 1.0% for Orange 3 and Red 1, and 0.7% for Yellow 3. In contrast, prevalence values for these same 4 dyes in type 3 studies were as high as 60.9%. There is considerable variation in the prevalence data for the Category 3 studies but the lowest value is usually greater than the lowest prevalence value for the dye in a Category 1 study.

Nondisperse dye prevalence

As shown in Table 5, only 6 of the nondisperse dyes – Acid Black 48, Basic Red 46, Basic Brown 1, Acid Yellow 61, Acid Red 118, and Acid Red 359 – have been used in more than 1 prevalence study. Interestingly, most of the studies are Category 1 studies, those in which the patients are NOT suspected, known, or very likely to be sensitive to textile dyes. Prevalence is consistently less than 0.4% in the Category 1 studies. No positive patch tests were obtained for 18 of the dyes listed when they were used in Category 1 studies. Prevalence values range from 9.2% for the 1 Category 3 for Basic Black 1 to 1.4% for the 1 Category 3 study for Basic Brown 1.

Discussion

The findings reported in textile-dye prevalence papers are valuable in defining the extent of human sensitivity to textile dyes as well as to specific dyes. More has been done to determine sensitivity to disperse than to nondisperse dyes. Available data indicates lower prevalence to nondisperse than to disperse dyes, that prevalence is probably less than 6% of eczematous patient populations patch tested with a number of different dyes to determine possible textile-dye sensitivity, and that sensitivity to any 1 dye is usually less than 2% in eczematous patient groups.

The data assembled in this article must be placed in perspective. First, the data are largely reflective of prevalence in Europe, primarily Italy. Only 1 study was conducted outside of Europe, i.e., North America. Prevalence values, therefore, should not be generalized to represent sensitivity in all countries.

Secondly, prevalence values presented reflect sensitivity to a dye placed directly on the skin and not sensitivity to a dyed textile. Prevalence would be expected to be lower if a dyed textile were placed on the skin rather than the dye itself, because the dye would have to transfer from the fabric to skin. Reactive dyes properly applied to fabric are not readily available for transfer from fabric to skin, as they are covalently bonded to the cellulose polymers of fibers (cotton, rayon, flax/linen) dyed with them. However, excess reactive dye on fabric is readily available for transfer. Dyes in the acid, basic, and disperse groups, while not covalently bonded to textile polymers, are usually strongly held within fibers due to current methods of dye application.

Thirdly, one should not infer that a person showing sensitivity to a dye in a patch test setting has developed sensitivity to the dye by wearing fabric colored with it. The primary sensitizer may be another product or be a cross-sensitization (13).

Fourth, certain dyes named as contact allergens may not be the contact allergens, especially those used in only 1 study and/or obtained directly from a manufacturer rather than a firm specializing in producing patch test allergen series. Dermatology teams usually did not check the purity nor identify of the dyes used in patch testing, which opens questions about each dye's purity and identity. In 1986, Foussereau & Dallara (16) found a problem with purity of several dyes in a commercially available patch test series. When dye products contain more than 1 compound, it may not be the dye molecule that causes the skin reaction but 1 of the other chemicals in the dye product. While the purity problem identified in the series has possibly

been rectified, no published research was found to confirm that dyes in those series are now pure and that the composition of same-named dyes in various patch testing series are chemically identical. Further, a study by Bide & McConnell (17) established that dye manufacturers do incorrectly label dyes and same-name dyes differ in formulation. Differences occur from batch to batch as well as from 1 manufacture to another. To illustrate purity and labeling problems, Bide & McConnell (15) show thin-layer chromatograms in which (a) 5 dyes marketed as Disperse Blue 3 are all chemically different, (b) 1 dye labeled as Disperse Violet 27 was actually Disperse Violet 1, and (c) 2 dyes labeled as Disperse Violet 1 which were not chemically identical. Only by testing with the dyes themselves and the contaminants will we learn the real, rather than the presumed allergen.

In summary, findings should not be inferred:

- to apply to the general population, as people tested were referrals to dermatology clinics;
- to apply to world-wide populations, as patients were usually European;
- to reveal sensitivity to dyed textiles, as dyes were applied directly to skin;
- to mean that textile dyes are primary sensitizers.

Further, it should not be concluded that all dyes named are the allergens, as dye purity and identity were not usually verified.

Recommendations

Additional prevalence studies are encouraged as 1 key in understanding sensitization of human populations to textile dyes. Such studies need to be done in North America, European countries other than Italy, and other world countries. Studies that are performed with people from the general population, rather than dermatologic referral populations, would add greatly to knowledge of sensitization to textile dyes. To assist in comparison of data collected in various countries and to track prevalence over time in any locale, a standard procedure or protocol would be invaluable.

Researchers are encouraged to include dyes for which little prevalence data has been collected. Those dyes listed in Tables 4 and 5 which have been used in only 1 prevalence study to date are prime candidates for use in future studies. An investigation to determine which dyes are used most for coloring apparel items, those to which there is greatest exposure, would be another source of candidates. Further, researchers are encouraged to include Disperse Blue 14 in 1 or more prevalence studies as Disperse Blue 14 was identified to have the properties of an ACD dye in a quantitative

structure activity relationship (QSAR) study undertaken by Hatch and Magee (18).

When future prevalence studies are designed and implemented, researchers are encouraged to verify the identity and purity of the dyes used, specially when the dyes are obtained directly from dye manufacturers. When reporting these studies, authors are encouraged to include sex distribution as well as a clear presentation of the number of patients who are patch test positive to each dye, and a prevalence for each dye as well as a prevalence for the study. Collaboration with industry and dye trade associations should expedite identification of the less sensitizing dye formulations.

The reviewed publications offer our best current insight into how frequent is the textile-dye ACD problem. Even with this growing corpus, we still remain unclear as to how often the positive patch tests biologically mean clinically relevant intolerance, and cross-reactivity, nor do we know threshold levels and clinical outcome.

References

1. Wilson E. Des stries et des macules atrophiques au fausses cicatrices de la peau. *Annual of Dermatology and Syphology* 1869: 141.
2. Balato N, Lembo G, Patruno C, Avala F. Prevalence of textile dye contact sensitization. *Contact Dermatitis* 1990; 23: 111–126.
3. Doooms-Goossens A. Textile dye dermatitis. *Contact Dermatitis* 1992; 27: 321–323.
4. Gasperini M, Farli M, Lombardi P, Sertoli A. Contact dermatitis in the textile and garment industry. In: Frosch P (ed): *Current topics in contact dermatitis*. Berlin: Springer-Verlag, 1989: 326–329.
5. Goncalo S, Goncalo M, Azenha M A, Barros A, Bastos A S, Brandão FM, Faria A, Marques M S J, Pecegueiro M, Rodrigues J B, Salgueiro E, Torres V. Allergic contact dermatitis in children. *Contact Dermatitis* 1992; 26: 112–115.
6. Lodi A, Ambonati M, Coassini A, Chirarelli, G, Mancini LL, Crosti C. Textile dye contact dermatitis in an allergic population. *Contact Dermatitis* 1998; 39: 314–315.
7. Manzini BM, Seidenari S, Danese P, Motolese A. Contact sensitization to newly patch tested non-disperse textile dyes. *Contact Dermatitis* 1991; 25: 331–332.
8. Manzini B M, Motolese A, Conti A, Ferdani G, Seidenari S. Sensitization to reactive textile dyes in patients with contact dermatitis. *Contact Dermatitis* 1996; 34: 172–175.
9. Manzini B M, Donini M, Motolese A, Seidenari S. A study of 5 newly patch-tested reactive textile dyes. *Contact Dermatitis* 1996; 35: 313.
10. Seidenari S, Manzini B M, Danese P. Contact sensitization to textile dyes: description of 100 subjects. *Contact Dermatitis* 1991; 24: 253–258.
11. Seidenari S, Manzini M, Schiavi M E, Motolese A. Prevalence of contact allergy to non-disperse azo dyes for natural fibers: A study in 1814 consecutive patients. *Contact Dermatitis* 1995; 33: 118–122.
12. Soni B P, Sherertz E F. Contact dermatitis in the textile industry: a review of 72 patients. *American Journal of Contact Dermatitis* 1996; 7: 226–230.
13. Seidenari S, Mantovani L, Manzini B M, Pignatti M. Cross-sensitization between azo dyes and para-amino compound. *Contact Dermatitis* 1997; 36: 91–96.

14. Wilkinson D S, Fregert S, Magnusson B, Bandman H-J, Calnan C D, Cronin E, Hjorth N, Maibach H I, Malten K E, Meneghini C L, Pirilä V. Terminology of contact dermatitis. *Acta Dermato-venereologica* 1970; 50: 287–292.
15. Seroi A, Farli M, Francalanci S, Gola M, Lombardi P. *Vantaggi di un nuovo metodo (Rapido) per l'esecuzione di patch test*. 8a Riunione G.I.D.C.A. Riassunto 57, 1987.
16. Foussereau J, Dallara M. Purity of standardized textile dye allergens: a thin layer chromatography study. *Contact Dermatitis* 1986; 14: 303–306.
17. Bide M J, McConnell B L. In-house testing of dyes. *Textile Chemist and Colorist* 1996; 28, no. 3 (March): 11–15.
18. Hatch, K L, Magee P. A discriminant model for allergic contact dermatitis in anthraquinone disperse dyes. *Quantitative Structure-Activity Relationships* 1998; 17: 20–26.
19. Cronin E. *Contact dermatitis*, 2nd edition. Edinburgh: Churchill Livingstone, 1980.
20. Fisher A A. *Contact dermatitis*, 3rd edition. Philadelphia: Lea and Febiger, 1986.

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