

Utility of Store and Forward Teledermatology for Skin Patch Test Readings

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Background: Teledermatology (TD) is the use of imaging technology to provide dermatology services at a distance. To date, studies assessing its application for grading skin patch test reactions have been lacking.

Objectives: The aim was to compare conventional, in-person (IP) grading of skin patch test reactions with store-forward TD.

Methods: Patients undergoing patch testing to the North American Contact Dermatitis Group (NACDG) screening series were invited to participate in this repeated-measures study. Photographs of the NACDG screening series patch sites were obtained at 2 time points (48-hour and final readings). Teledermatology assessments were completed by the same staff dermatologist who performed the IP readings; 48-hour and final TD photographs were viewed at weeks 4 and 8 after the IP encounter, respectively, to prevent recall bias. Staff dermatologists were blinded to IP grading results. The main outcome was percent agreement. Eight categories of agreement were created according to possible pairings of TD and IP reading results. Three final outcome groups of “success,” “indeterminate,” and “failure” were defined based on clinical significance.

Results: One hundred one participants completed the study. There were 7070 comparison points between IP and TD final readings. Excluding negative/negative agreement, there was “success” of TD in 54% of final readings. “Indeterminate” agreement with possible clinical significance was present in 40% of final readings. There was “failure” (definite clinical significance) in 6% of final readings.

Conclusions: Teledermatology may be a viable option for grading skin patch test reactions, particularly for clinicians who perform limited patch testing. However, a clinically significant “failure” rate of 6% and practical barriers to TD implementation may preclude its widespread use for skin patch testing in tertiary referral centers where large numbers of patches are tested per patient.

Teledermatology (TD) is the use of imaging technology to provide dermatology services at a distance.¹ There are 2 main TD systems, store-forward TD and real-time interactive TD. In store-forward TD (also called “store-and-forward”), asynchronous: still images of the patient’s skin are transmitted electronically to a teledermatologist who can review the images and provide a clinical assessment and plan. The advantages of store-forward TD include convenience (to patient and remote dermatologist), accessibility, and cost.²

A large body of literature has evaluated the utility of TD in general dermatology settings.³ The technology is useful both as a way to provide dermatological care to patients in rural or remote settings and as a means of triaging skin complaints.^{4–6} Some studies have found that TD is both accurate and reliable for general referred skin complaints, whereas others document inferiority for malignant lesions, especially pigmented lesions, the most worrisome category of dermatologic disease.^{7–12} There are a few TD studies involving dermatitis^{6,7,9,13–15}; in a small study, Baumeister et al¹⁶ found a tendency to assess hand dermatitis more critically in TD examination compared with in-person (IP) examination among 100 male “wet workers.”

Little is known regarding the application of TD for skin patch testing. Jacob et al¹⁷ proposed utilization of TD services for prepatch test consultation and postpatch test counseling. Although some practicing clinicians may already utilize digital images for assessment of skin patch test reactions (ie, patient provides photographs of late reactions or regular readings of patch test areas), to our knowledge, this is the first study to formally assess its use.

The primary objective of this study was to compare conventional, IP grading of skin patch test reactions with store-forward TD, using the outcome of agreement. We hypothesized agreement

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between IP and TD grading within the categories of true positive (+++, ++, +) reactions as well as negative reactions would be high. We expected more discordance in grading of irritant and doubtful reactions.

METHODS

Overview and Institutional Review Board

This clinical study was approved by the Institutional Review Board of the Minneapolis Medical Research Foundation of Hennepin County Medical Center (HCMC). One hundred one participants were recruited and enrolled from December 2015 through May 2016.

Inclusion/Exclusion Criteria and Recruitment

Inclusion criteria included: patients age 18 years or older undergoing patch testing to the North American Contact Dermatitis Group (NACDG) screening series at the HCMC Parkside Occupational and Contact Dermatitis Clinic. Exclusion criteria included inability to provide informed consent due to language or other barriers. Eligible individuals were invited to participate at their second clinic visit (48-hour IP patch test reading) by a study investigator (K.G., S.L.H.).

Study Photographs

After completion of informed consent, a study investigator (K.G., S.L.H.) obtained digital photographs of the NACDG screening series skin patch testing sites (70 patches). All photographs were taken using an iPad Pro camera using standard settings and stored on a secure hospital server by subject ID number. Photographs were taken directly perpendicular ("head on") to the testing sites. Each photograph included up to 20 standard 8-mm aluminum Finn Chambers (SmartPractice, Phoenix, Ariz) (ie, 2 strips of 10 patches per image except allergens 60–70, Fig. 1). No patient identifiers were included in the photographs. Standard examination room lighting was used, with patients in the same position as the IP reading. To ensure quality control, the images were viewed during image acquisition to check lighting and overall image quality.

Standard, IP Grading

One of 2 staff dermatologists with clinical expertise in patch testing (E.W., S.A.H.) performed the 48-hour IP reading. Patch tests were graded according to NACDG criteria as follows: 6, no reaction; 4, doubtful (faint erythema with no induration); +, mild (erythema, induration, +/- papules); ++, strong (erythema, induration, papules, vesicles); +++, very strong (intense erythema, induration, coalescing vesicles, bullae, spreading); and 5, irritant. The results of the readings were recorded on the standard clinic grading sheet.

The same photography and IP reading procedures were repeated at the patient's third clinic visit (final 96–168 hour reading, Fig. 2). The IP reading data were entered by subject ID number into Excel (Microsoft Corporation, Redmond, Wash) by a study investigator (K.G.).

TD Encounters

At least 4 weeks after the patients' date of informed consent, the same staff dermatologist who performed the IP reading viewed the 48-hour digital photographs and graded reactions according to the same NACDG criteria as the IP examinations. The teledermatologist was blinded to IP results and each teledermatologist used the same standard clinic desktop computer for all assessments.

Four weeks after the 48-hour TD readings (at least 8 weeks from informed consent), the same staff dermatologist viewed the digital photographs from the final (96–168 hours) reading and graded these reactions according to the same NACDG criteria as the IP examinations. The teledermatologist was blinded to IP results as well as 48-hour TD reading results. The time frame of at least 4 weeks was chosen to decrease recall bias. To avoid inter-rater variability, only the dermatologist who graded the IP reactions graded the TD images.

The TD encounter results were entered by a study investigator (K.G.) into Excel, by subject ID number. For data quality control, data for every 10th participant was reentered in a separate Excel sheet by a different study investigator (S.L.H.); no errors were detected in this 10% double-data entry.

Statistical Analysis

The primary outcome measure was agreement of TD and standard IP clinic grading of skin patch test reactions. Eight categories of agreement were created according to possible pairings of TD and IP reading results. Three final groups of "success," "indeterminate," and "failure" were defined based on clinical significance. "Success" consisted of 3 categories: *complete agreement* (exact match of +++/++/, doubtful or irritant values); *partial agreement* (+++/++/+ on both IP and TD readings, but not exact match); and *negative/irritant disagreement* (negative on one reading vs irritant on other). The "indeterminate" group consisted of 4 categories: *positive/irritant disagreement* (+++/++/+ on one reading vs irritant on other); *negative/doubtful disagreement* (negative on one reading vs doubtful on other); *doubtful/irritant disagreement* (doubtful on one reading vs irritant on other); and *doubtful/positive disagreement* (doubtful on one reading vs +++/++/+ on other). "Failure" consisted of 1 category: *complete disagreement* (negative on one reading vs +++/++/+ on other).

The primary outcome measure was the percent agreement on the final reading of skin patch test reaction grading. Frequency statistics were calculated for the total number of reactions (positive [+++/++/+], irritant, or doubtful on either the TD or the IP assessment) per patient. For individual allergens, only positive (+++/++/+) reactions were presented. Agreement between TD and IP clinic readings was empirically evaluated with frequency statistics for different types of agreement and disagreement. Failure rates were also stratified by provider. Data was managed with Microsoft Excel (Microsoft Corporation, Redmond, Wash) and analyzed using the R software environment (R: A language and

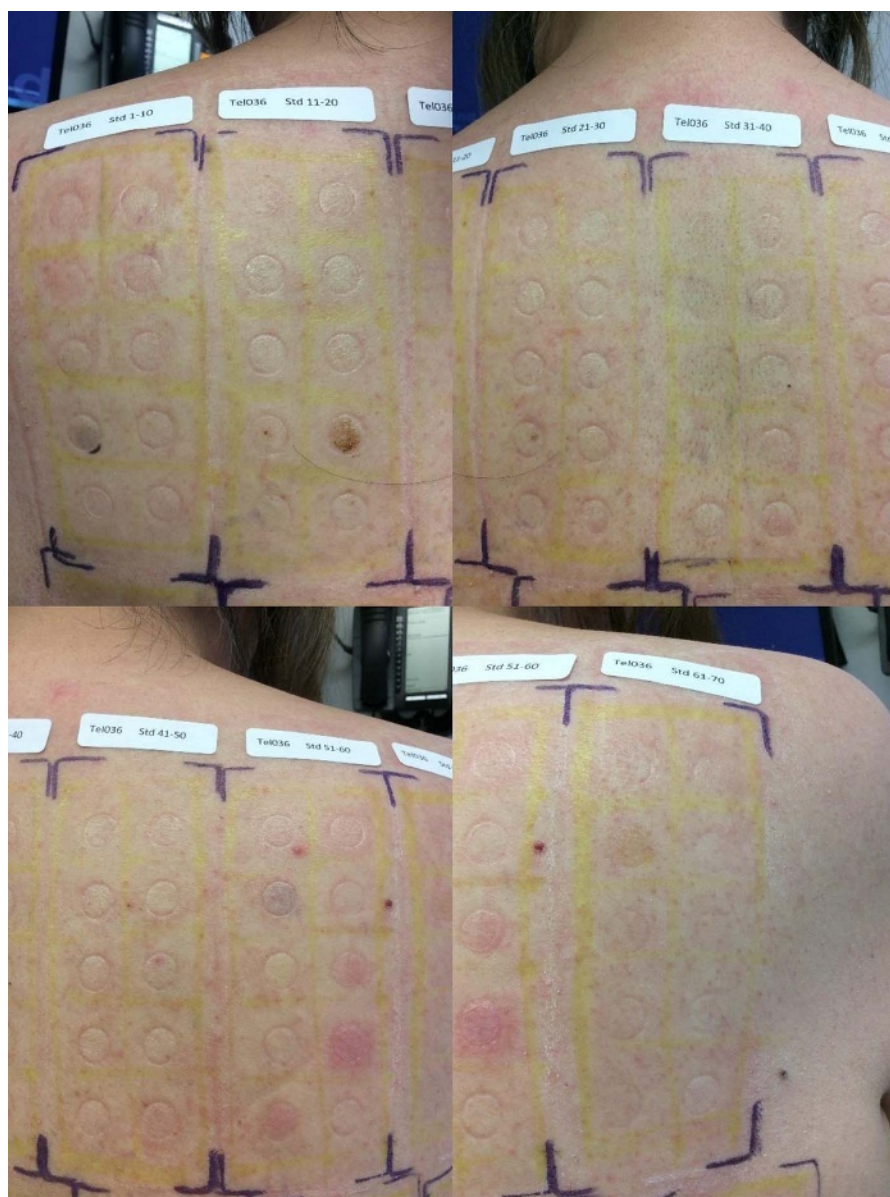


Figure 1. Example of TD photographs of the 70 NACDG screening allergens obtained at a participant's 48-hour IP reading.

environment for statistical computing; R Core Team, R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Participant Characteristics

Over 6 months, 107 patients undergoing patch testing at the HCMC Occupational and Contact Dermatitis Clinic were invited to participate. One hundred one (94.4%) agreed to participate and completed the study. Most participants were women (72%); mean age was 50 years. Almost all had the NACDG screening series placed on their back ($n = 94$), 5 individuals had testing performed on the legs (due to dermatitis on the back), and 2 had tests placed on both their back and arms.

Characterization of Reactions

Ninety-nine participants (98.0%) had at least 1 reaction (+++, ++, +, or doubtful) to a NACDG screening series allergen on either IP or TD readings (Table 1). Positive reactions (excluding doubtful and irritant reactions) on the IP or TD readings were most common to methylisothiazolinone, followed by nickel sulfate hexahydrate, and 2-hydroxyethyl methacrylate (Table 2).

Agreement Between IP and TD

There were 7070 comparison points between IP and TD readings at both time points (Tables 3 and 4). Excluding negative/negative complete agreement, there was "success" of TD in 47% of 48-hour readings and 54% of final readings. "Indeterminate" agreement

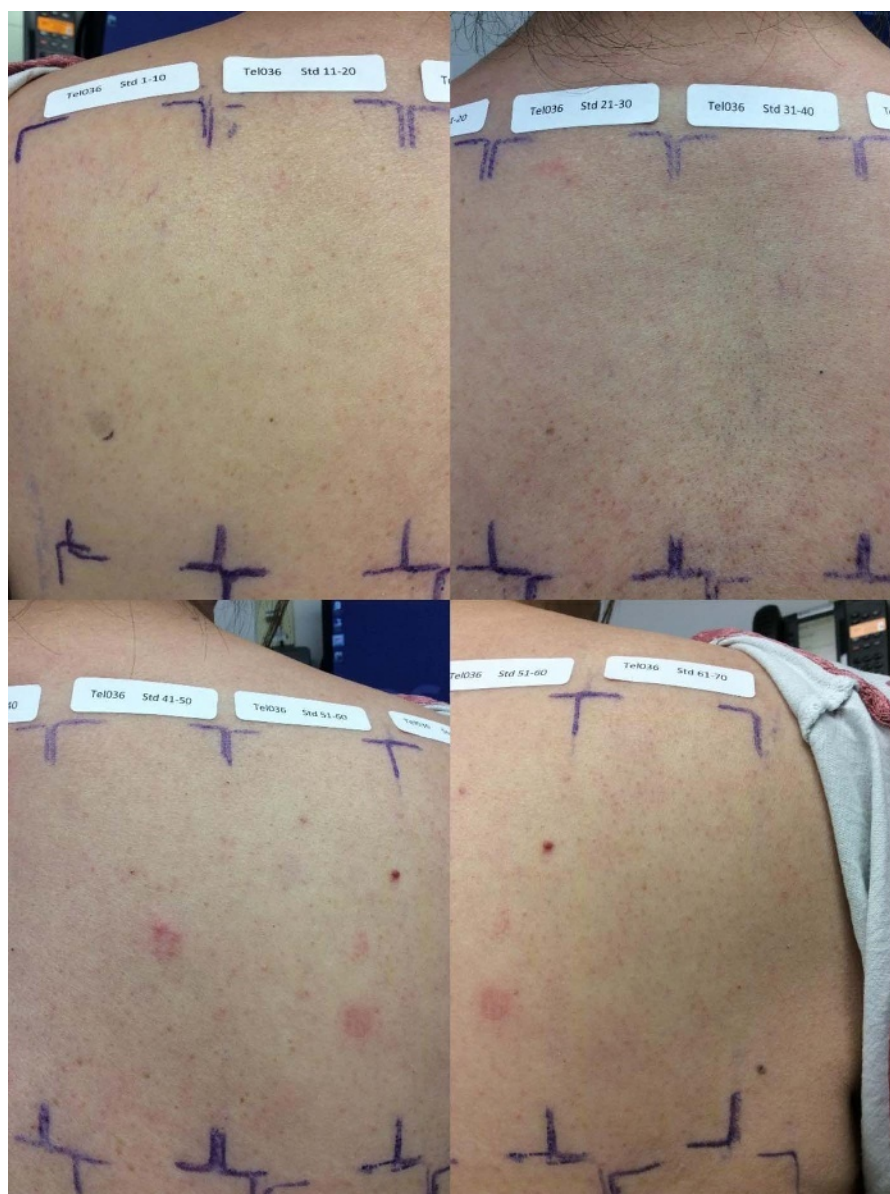


Figure 2. Example of TD photographs of the 70 NACDG screening allergens obtained at a participant's final (96–168 hours) IP reading.

TABLE 1. Number of Reactions

No. Reactions*	No. Participants (%), N = 101
0	2 (2.0)
1	5 (5.0)
2	5 (5.0)
3	7 (6.9)
4	9 (8.9)
5	4 (4.0)
6	8 (7.9)
7	9 (8.9)
8	10 (9.9)
9	8 (7.9)
≥10	34 (33.7)

*Includes very strong, strong, mild, and doubtful on IP or TD reading.

with possible clinical significance was present in 51% of 48-hour readings and 40% of final readings. There was “failure” (definite clinical significance) in 2% of 48-hour readings and 6% of final readings. Failure rate was also stratified by provider. There were no statistically significant differences in the failure rates at either 48 hours (1.5% vs 1.7%, $P = 1.0$) or final readings (5.5% vs 9.6%, $P = 0.16$).

Directional Discordance in “Indeterminate” and “Failure” Groups

Of the 362 pairs in the “indeterminate” group of possible clinical significance at 48 hours, there were 197 TD undercalls and 165 TD overcalls. Of the 167 pairs in the “indeterminate” group at the final reading, there were 116 TD undercalls and 51 TD overcalls.

TABLE 2. Frequency of Positive (+++, ++, or +) Reactions by Allergen

NACDG Screening Series Allergen	No. Participants	Percentage, N = 101
Methylisothiazolinone, 0.2% aq	34	33.7
Nickel sulfate hexahydrate, 2.5% pet	30	29.7
2-Hydroxyethyl methacrylate, 2.0% pet	25	24.8
Formaldehyde, 1.0% aq	24	23.8
Fragrance mix I, 8.0% pet	24	23.8
Formaldehyde, 2.0% aq	22	21.8
Colophonium (rosin), 20.0% pet	21	20.8
Methylchloroisothiazolinone/methylisothiazolinone, 0.01% aq	20	19.8
Propylene glycol, 100%	17	16.8
Fragrance mix II, 14.0% pet	16	15.8
Carba mix, 3.0% pet	16	15.8
Thiuram mix, 1.0% pet	16	15.8
Oleamidopropyl dimethylamine, 0.1% aq	16	15.8
<i>Cananga odorata</i> flower oil (ylang-ylang oil), 2.0% pet	15	14.9
Bacitracin, 20.0% pet	12	11.9
Methyldibromoglutaronitrile/phenoxyethanol (MDBGN/PE) 2.0% pet	12	11.9
<i>Myroxylon perei</i> resin (balsam of Peru), 25.0% pet	10	9.9
Cinnamic aldehyde, 1.0% pet	10	9.9
Ammonium persulfate, 2.5% pet	10	9.9
DMAPA 1.0% aq	9	8.9
Lanolin alcohol (Amerchol L101), 50% pet	9	8.9
Cobalt(II) chloride hexahydrate, 1.0% pet	9	8.9
Compositae mix, 6.0% pet	9	8.9
Quaternium 15, 2.0% pet	8	7.9
4-tert-butylphenol formaldehyde resin, 1.0% pet	8	7.9
Propylene glycol, 30.0% aq	8	7.9
Methyl methacrylate, 2.0% pet	8	7.9
<i>Mentha piperita</i> oil (peppermint oil), 2.0% pet	8	7.9
4-phenylenediamine, 1.0% pet	7	6.9
Cocamidopropyl betaine, 1.0% aq	7	6.9
Benzocaine, 5.0% pet	6	5.9
Amidoamine (stearamidopropyl dimethylamine), 0.1% aq	4	4.0
Diphenylguanidine, 1% pet	4	4.0
Ethyl acrylate, 0.1% pet	4	4.0
Cocamide DEA, 0.5% pet	4	4.0
<i>Melaleuca alternifolia</i> (tea tree leaf oil), oxidized, 5.0% pet	4	4.0
Decyl glucoside, 5.0% pet	4	4.0
Diazolidinyl urea (Germall II), 1.0% pet	3	3.0
Iodopropynyl butylcarbamate, 0.5% pet	3	3.0
Tosylamide formaldehyde resin, 10.0% pet	3	3.0
Propolis, 10.0% pet	3	3.0
Lidocaine-hydrochloride, 15.0% pet	3	3.0
Ethylenediamine dihydrochloride, 1.0% pet	2	2.0
Bisphenol A epoxy resin, 1.0% pet	2	2.0
Potassium dichromate, 0.25% pet	2	2.0
Disperse blue mix (124/106), 1.0% pet	2	2.0

None of the participants reacted to the following allergens: 2-mercaptobenzothiazole, 1.0% pet; neomycin sulfate, 20.0% pet; ethylhexylglycerin, 5% pet; black rubber mix, 0.6% pet; Dimethylol-dimethyl hydantoin, 1.0% pet; imidazolidinyl urea, 2.0% pet; mixed dialkyl thioureas, 1.0% pet; paraben mix, 12.0% pet; 2-bromo-2-nitropropane-1,3-diol (bronopol), 0.5% pet; sesquiterpene lactone mix, 0.1% pet; benzophenone-3, 10% pet; chloroxylonol, 1.0% pet; parthenolide, 0.1% pet; desoximetason, 1.0% pet; tocopherol, 100.0%; benzophenone-4, 10% pet; tixocortol-21-pivalate, 1.0% pet; budesonide, 0.1% pet; hydrocortisone-17-butyrate, 1.0% pet; clobetasol-17-propionate, 1.0% pet; chlorhexidine digluconate, 1% aq; carvone, 5.0% pet; *Lavandula angustifolia* oil (lavender oil), 2.0% pet; hydroquinone, 1.0% pet. DMPA, dimethylaminopropylamine; DEA, diethanolamide.

TABLE 3. Summary of Agreement at 48-h Reading Between IP and TD (N = 7070)

IP	TD					IR
	Negative	?	+	++	+++	
Negative	6365*†	144‡	3§	0§	0§	2
?	173‡	226†	21¶	0¶	0¶	0#
+	8§	23¶	54†	3**	0**	0††
++	0§	1¶	10**	16†	4**	0††
+++	0§	0¶	0**	1**	12†	0††
IR	2	0#	0††	0††	0††	2†

*Negative/negative agreement excluded in final percent agreement.

†Complete agreement.

‡Negative/doubtful disagreement.

§Complete disagreement.

||Negative/irritant disagreement.

¶Doubtful/positive disagreement.

#Doubtful/irritant disagreement.

**Partial agreement.

††Positive/irritant disagreement.

? indicates doubtful; IR, irritant.

Of the 11 pairs in the “failure” group at 48 hours, there were 3 TD undercalls (IP+ vs TD negative) and 8 TD overcalls (IP negative vs TD+). All were mild (+) versus negative discordance pairs. Antigens involved included amidoamine, propylene glycol 100%, decyl glucoside, oleamidopropyl dimethylamine (n = 3), tocopherol, ammonium persulfate, methylidibromoglutaronitrile/phenoxylethanol, diphenylguanidine, and hydrocortisone-17-butyrate.

Of the 27 pairs in the “failure” group at the final reading, there were 7 TD undercalls (IP +/+/+/+ vs TD negative) (Fig. 3) and 20 TD overcalls (IP negative vs TD +/+/+) (Fig. 4). Twenty-four pairs were mild (+) versus negative, 2 pairs were strong (++) versus negative, and 1 pair was very strong (+++) versus negative discordance. Antigens with mild (+) versus negative discordance included propolis, formaldehyde 2.0% (n = 2), ethyl acrylate, cocamidopropyl betaine, neomycin sulfate, fragrance mix I, cobalt chloride hexahydrate, propylene glycol 100% (n = 2), balsam of Peru (n = 2), methylchloroisothiazolinone/methylisothiazolinone 0.01%, nickel sulfate hexahydrate, ammonium persulfate, quaternium 15 (n = 2), lanolin alcohol, dimethylaminopropylamine, diphenylguanidine, cinnamic aldehyde, oleamidopropyl dimethylamine (n = 2), and 4-phenylenediamine. The 2 strong (++) versus negative discordant reactions occurred in the same study participant to cobalt chloride hexahydrate and tixocortol-21-pivalate, antigens tested next to one another (antigens 48 and 49) on the NACDG screening series. The very strong (+++) versus negative discordant reaction occurred to methyl methacrylate; positive on IP, negative on TD.

DISCUSSION

There are several important findings of this study. Teledermatology was “successful” (no clinically significant differences) in 54% of final readings. Conversely, TD “failed” in 6% of pairs at the final reading. Given the high frequency of doubtful

reactions, clinical significance was “indeterminate” in 40% of final pairs.

“Teledermatology Success Group”

As outlined in Table 5, we divided categories of agreement by clinical significance. Slightly over half (54%) of comparison points from the final grading were included in the “success” category with no clinically significant difference. Counseling on avoidance of allergens would have been identical regardless of whether the grading of reactions was done IP or via store-forward TD.

“Teledermatology Failure Group”

Clinically significant differences between the IP and TD reading (ie, negative vs +/+/+, ++, or + discordance) comprised the “failure” group. Six percent of comparison points from the final reading were in this category. Interestingly, a majority of the “failure group” were TD overcalls (ie, IP negative, TD +, 74%). Although the majority of pairs involved mild (+) versus negative discordance, 2 pairs were strong (++) versus negative, and 1 pair was very strong (+++) versus negative. The 2 strong (++) versus negative discordant reactions occurred in the same study participant to cobalt chloride hexahydrate and tixocortol-21-pivalate, antigens tested next to one another (antigens 48 and 49) on the NACDG screening series (Fig. 5). These discordant reactions likely represent a counting/position error during the TD encounter. The very strong (+++) versus negative discordance occurred in a participant with very strong (+++) reactions to antigen 47 (methyl methacrylate) and antigen 48 (cobalt chloride hexahydrate) on the IP reading. On the TD encounter, antigen 48 was graded +/+/+, whereas antigen 47 was graded negative. The clinician likely interpreted antigen 48 as a robust, spreading reaction on the TD encounter; as shown in Figure 6, central pallor is present at the site of antigen 47. Possible explanations for the other discordant

TABLE 4. Summary of Agreement at Final Reading Between IP and TD Grading (N = 7070)

IP	TD					IR
	Negative	?	+	++	+++	
Negative	6650*†	38‡	6§	1§	0§	0
?	91‡	45†	10¶	2¶	0¶	1#
+	18§	25¶	83†	13**	0**	0††
++	1§	0¶	22**	38†	2**	0††
+++	1§	0¶	0**	6**	14†	0††
IR	3	0#	0††	0††	0††	0†

*Negative-negative agreement excluded in final percent agreement.

†Complete agreement.

‡Negative/doubtful disagreement.

§Complete disagreement.

||Negative/irritant disagreement.

¶Doubtful/positive disagreement.

#Doubtful/irritant disagreement.

**Partial agreement.

††Positive/irritant disagreement.

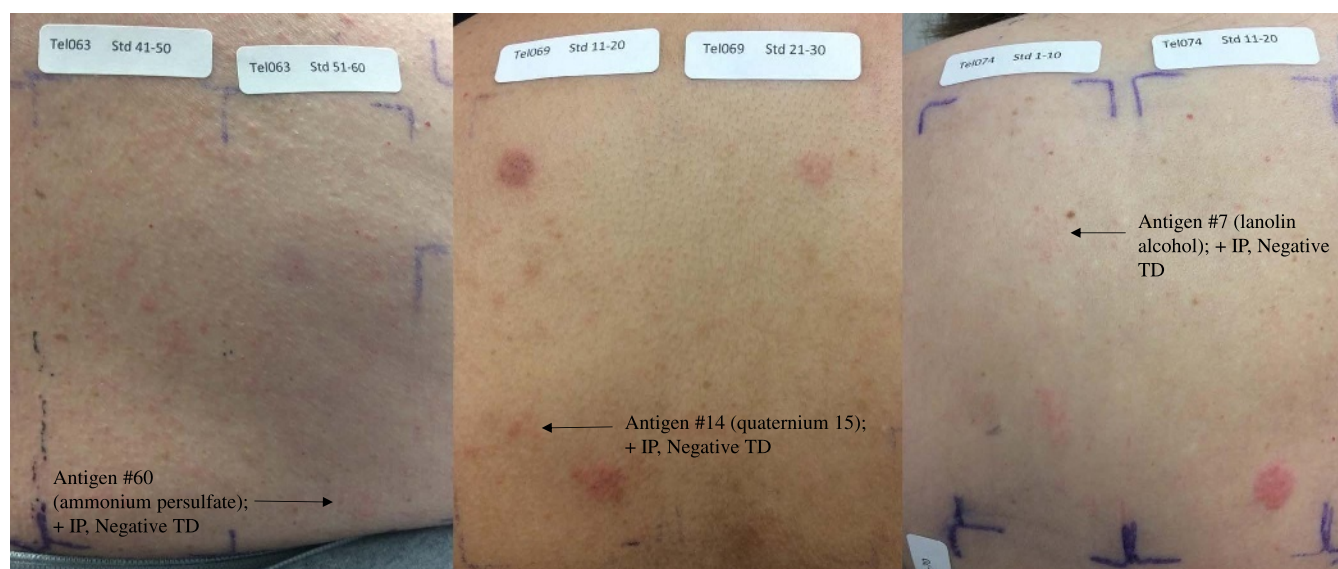


Figure 3. TD photographs depicting TD undercalls (+IP, negative TD) in 3 study participants.

comparison points may include differences in lighting, lack of tactile cues in TD, and/or lack of subjective information (ie, itching at the site). Discordances could also be due to the borderline irritant nature

of the specific allergens involved (eg, cocamidopropyl betaine, cinnamic aldehyde, methyl dibromoglutaronitrile/phenoxylethanol, tocopherol, propylene glycol, amidoamine, and balsam of Peru all have been identified as “problematic” preparations based on positivity ratios/reaction indices¹⁸) and/or rebound erythema of corticosteroids (eg, hydrocortisone-17-butyrate).¹⁹

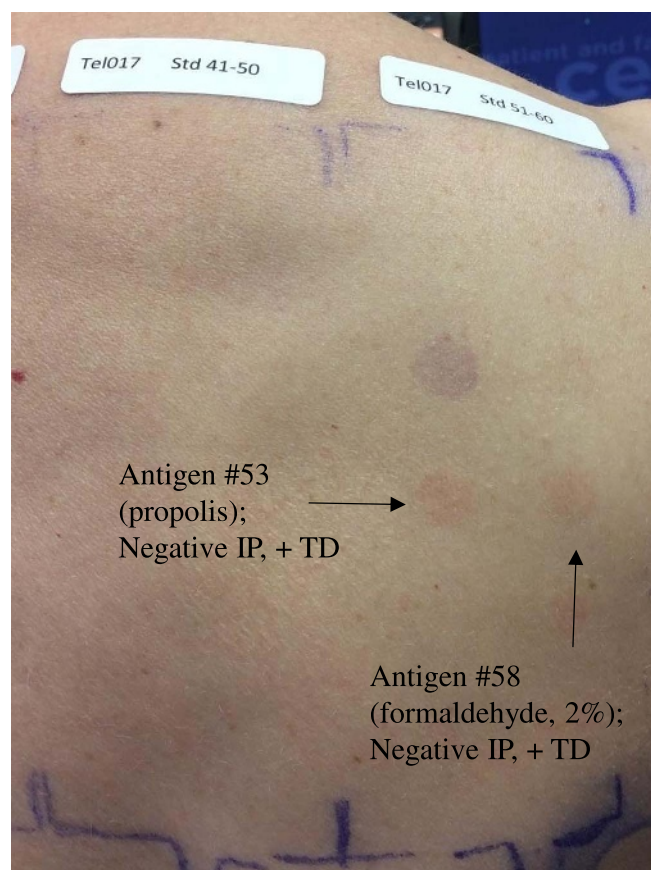


Figure 4. TD photograph depicting TD overcalls (negative IP, +TD) in a study participant.

“Indeterminate Group”

In general, macular erythema or a reaction that does not fill the chamber is graded as a doubtful reaction. A large body of literature discusses the difficulties in interpretation of doubtful reactions as positive, negative, or irritant.^{20–22} In standard patch test practice, clinical history may help in interpreting these reactions. Because clinical history was not provided to the TD evaluators as part of this study, it was difficult to establish relevance in examining discordances that included doubtful or irritant reactions. Many (40%) comparison points between the IP and TD grading were categorized as “indeterminate.” These included doubtful/negative discordance or doubtful/irritant discordance or doubtful/positive (+++, ++, +) discordance. Among the 167 “indeterminate” pairs of possible clinical significance, most were doubtful/negative discordance (77%) and TD undercalls (69%) (ie, IP positive, TD negative). We propose that adding a final interpretation code (rather than just using the grade for the final reading), such as “allergic” or “not allergic,” could help eliminate some of these “possibly clinically significant” comparison points by incorporating information on related allergens (eg, a doubtful reaction to a formaldehyde-releasing allergen would likely be graded with a final interpretation as “allergic” in the setting of multiple reactions to other formaldehyde-releasing allergens) or clinical history (eg, a doubtful reaction to a preservative would likely be graded with a final interpretation as “allergic” in the setting of a positive reaction

TABLE 5. Agreement Between IP and TD Grading at 48-h and Final Readings (Excludes Negative/Negative Complete Agreement)

Type of Agreement	48-h Reading (N = 705)	Final Reading (N = 420)
“Success” (no clinical significance)		
Complete agreement (exact match of +++/+++, doubtful, or irritant values)	310 (44.0%)	180 (42.9%)
Partial agreement (+++/+++/+ on both evaluations but not exact match)	18 (2.6%)	43 (10.2%)
Negative/irritant disagreement	4 (0.6%)	3 (0.7%)
Total for “success”	332 (47.2%)	226 (53.8%)
“Indeterminate” (possible clinical significance)		
Positive/irritant disagreement (+++/+++/+ vs irritant)	0 (0%)	0 (0%)
Negative/doubtful disagreement	317 (45.0%)	129 (30.7%)
Doubtful/irritant disagreement	0 (0%)	1 (0.2%)
Doubtful/positive disagreement (+++/+++/+ vs doubtful)	45 (6.4%)	37 (8.9%)
Total for “indeterminate”	362 (51.3%)	167 (39.8%)
“Failure” (definite clinical significance)		
Complete disagreement (negative vs +++/+++/+)	11 (1.6%)	27 (6.4%)

to a personal care product containing this allergen and used in the location of the dermatitis).

Comparison of Current Study to Other TD Studies

To our knowledge, this is the first study to assess application of TD for grading skin patch test reactions. However, a large body of literature has evaluated TD for other dermatologic conditions. Many chronic dermatologic diseases, such as psoriasis or eczema, may be more amenable to TD evaluation because the overall quality and distribution of the lesions may be sufficient for diagnosis. Fine, detailed observations may not be as important in the TD encounter and long-term monitoring may be accurate, reliable, and efficient.^{15,23–25} Conversely, diagnosis and management of more discrete lesions, such as a skin neoplasms or patch test reactions, is enhanced by tactile evaluation and subtle visual clues of color and texture, which may not be available using store-forward TD.^{10,11} For example, patch test clinicians often palpate for papules or evaluate irritant “glazing” or “wrinkling” by indirect lighting.²⁶ Eliciting patient symptoms of “itching” at the site is also used by some clinicians. Future studies may evaluate the addition of other imaging tools (eg, dermoscopy) to determine if these aid in overcoming TD shortcomings.

Barriers to TD Implementation

In many clinics, there are practical considerations that may preclude routine implementation of TD for grading skin patch test reactions, especially in tertiary referral clinics where large numbers of patches are tested. First, trained personnel confirm adequate adhesion and occlusion of patch sites and perform the removal and marking of patches. This includes careful removal of tape, verification of patch locations with a map, and pen markings to ensure accuracy at both the 48-hour and final readings. If multiple series are tested, patch removal and marking may be difficult for patients to perform at home without significant training. Patch location could be marked at the time of application (before additional tape

is added), but the accuracy and duration of such markings has not been verified in a standardized way, to our knowledge. Second, there would likely be variability in the quality of photographs taken by patients at home that may hinder interpretation via TD. Finally, in our clinic, additional patches are often applied at the 48-hour

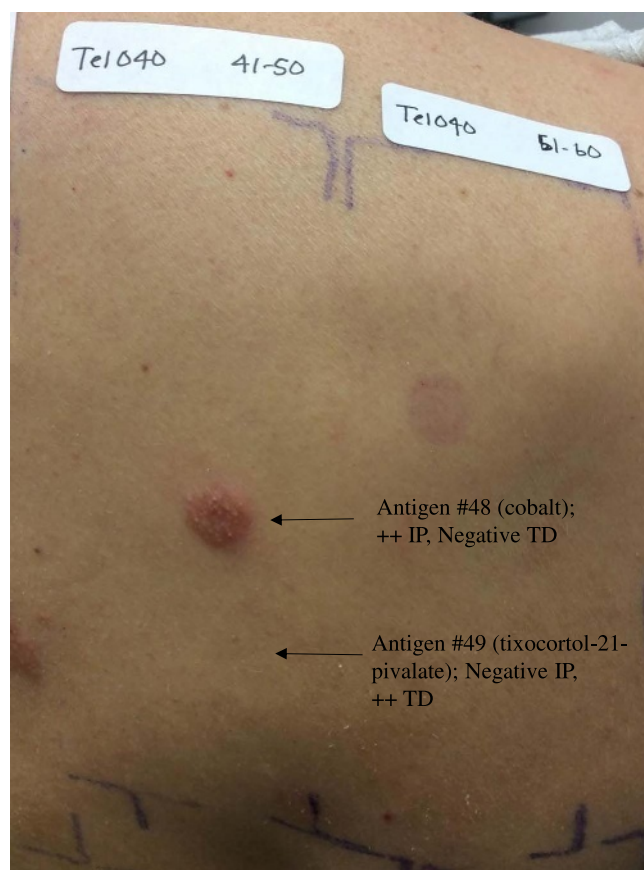


Figure 5. TD photograph depicting the two strong (++) versus negative discordant reactions in the same study participant. Antigen 48 (cobalt chloride hexahydrate) was graded as ++ IP, negative TD. Antigen 49 (tixocortol-21-pivalate) was graded negative IP, ++TD.

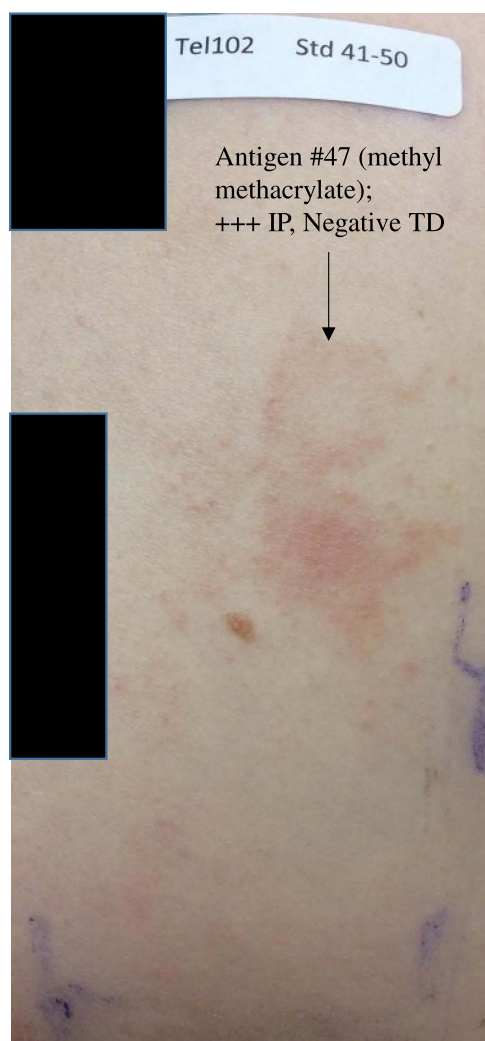


Figure 6. TD photograph depicting the very strong (+++) versus negative discordant reaction in a study participant. Antigen 47 (methyl methacrylate) was graded as +++ IP, negative TD. Black bars placed to de-identify photograph.

reading including personal products elicited on initial intake history or antigens based on preliminary positive reactions at 48 hours. This would not be possible if TD were used for 48-hour readings.

Limitations

There are several limitations to this study. First, this pilot study assessed the use of TD solely for grading the 70 allergens in the NACDG screening series. Future studies may consider including additional series, personal products, TRUE Test (SmartPractice, Phoenix, Ariz), or other screening series. Second, only 2 dermatologists conducted readings. Variations in readings may differ by dermatologist.

CONCLUSIONS

In summary, TD may be a viable option for grading skin patch test reactions, particularly for experienced clinicians who perform

limited patch test series or who perform testing on patients who live quite a distance from clinic. Using store-forward technology of testing sites has the potential to diminish overhead clinic costs,²⁷ lower the burden of travel for patients, and increase access to skin patch testing services in certain circumstances. However, a clinically significant “failure” rate of 6% and practical barriers to TD implementation may preclude its widespread use for skin patch testing in tertiary referral centers.

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