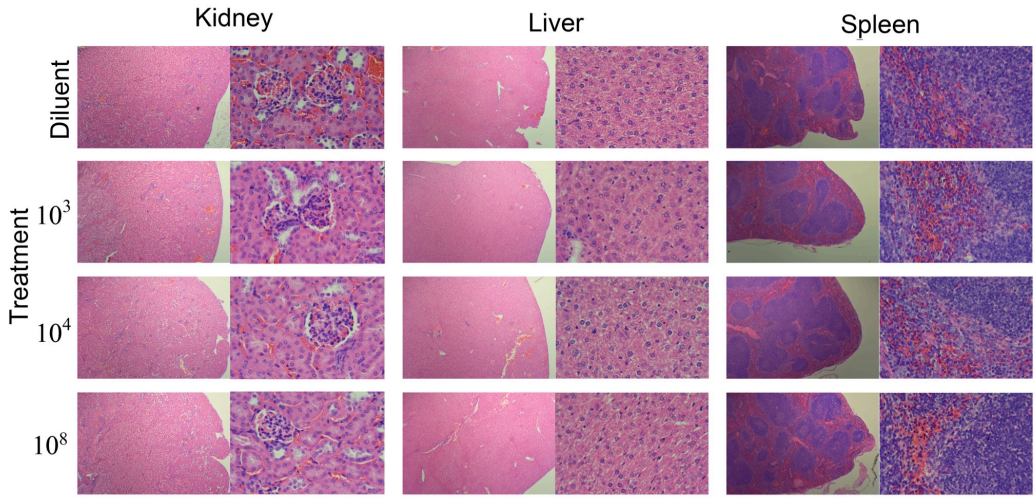
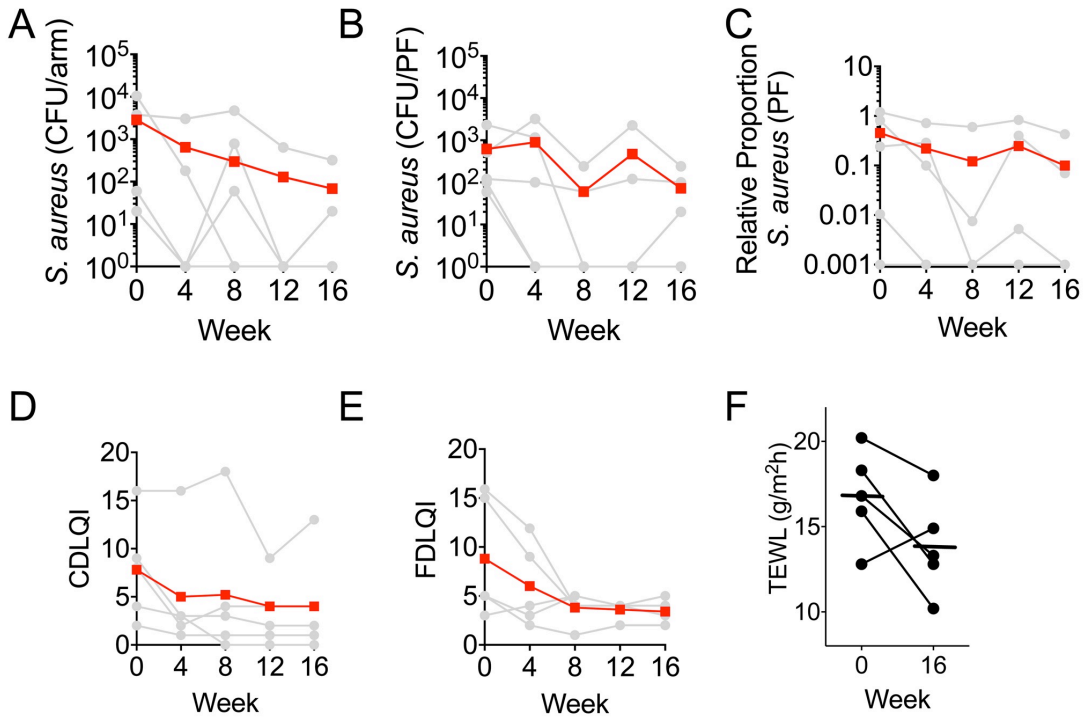
Supplemental Figure 1



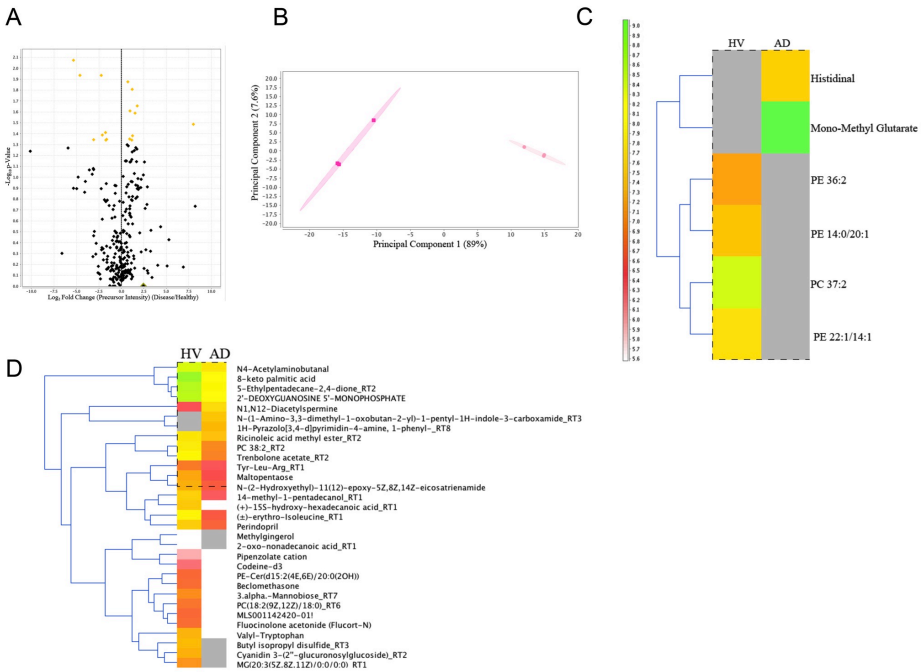
Intravenous injection of *R. mucosa* is non-toxic in mice. Wild type (C57BL/6) mice were injected with diluent or *R. mucosa* IV at 10^3, 10^4, or 10^8 CFU in 100mcL of volume. Weights and activities were monitored daily for 10 days. On day 10 the kidney, liver, and spleen were harvested and compared histologically (N = 5 mice per group). Representative images from one mouse per group at both 4x and 20x magnification are shown. Studies were conducted with the therapeutic *R. mucosa* strains included in the clinical trial as well as ATCC BAA-692.

Supplemental Figure 2



***R. mucosa* treatment secondary measurements**. (A-B) *S. aureus* burden for antecubital (A) and popliteal (PF; B) fossae. (C) Ratio of *S. aureus* to coagulase negative *staphylococci* for the popliteal fossae during treatment. (D-E) Mean (scarlet) and individual (gray) values for the Children's (D) and Family (E) Dermatology Quality Life Index (CDLQI and FDLQI) are shown. (F) Mean (lines) and individual (dots) of trans-epidermal water loss (TEWL) measurements at enrollment (week 0) and post-treatment (week 16).

Supplemental Figure 3



Metabolic profiles from strains of *R. mucosa* differ in ways consistent with atopic dermatitis pathology. Bacterial pellets from three strains from healthy volunteers (HV) and three from patients with atopic dermatitis (AD) were grown to mid-exponential phase, pelleted, frozen, and sent for metabolomic comparison by RPLC (A-C) or HILIC (D). (A) Volcano plot of significance vs. fold-change for differentiating metabolites . Yellow dots indicate significant differences prior to family-wise error rate (FWER) adjustment. (B) Principal component analysis for the six strains (HV strains dark pink, AD strains light pink). (C) Heat map for $\log_{10}$ transformed peak area counts of metabolites statistically significant after FWER adjustment. (D) As in C, using HILIC prior to FWER adjustment. PE = phosphatidylethanolamine, PC = phosphatidylcholine. Gray indicates no mass spec signal seen for the indicated metabolite in any of the three isolates tested. Full dataset uploaded to Metabolomics Workbench.

Table S1: Treatment related and emergent unexpected problems and adverse events

	Adult cohort (n=10)	Pediatric cohort (n=5)
Treatment-related unexpected problems*, n (%)		
Application site pruritus	0	1 (20)
Treatment-related adverse events§, n		
Application site pruritus	0	0
Application site pain	0	0
Fever	0	0
Discoloration	0	0
Worsening pruritus	0	0
Worsening SCORAD	0	0
Infection, skin	0	0
Infection, other	0	0
Injury	0	0
Headache	0	0
Cough	0	0
Lab abnormalities (see methods)	0	0
Treatment-emergent adverse events#, n	0	0

*Problems related to therapy by timing; self-limited and did not interfere with patient's daily activities or treatment compliance.

§Problems related to therapy by timing; persistent and/or interfering with patient's daily activities or treatment compliance.

#Problems related to therapy by timing; requiring any medical intervention.

Demographics Adult Cohort				Intake SCORAD	PMHx	Home AD Regimen	Antecubital SCORAD			Pruritus			FHx
Patient	Sex	Age	Race				Pre	Post	Change	Pre	Post	Change	
1	F	43	W	27.9	AR	E, CS	11	9	-18%	8	6	-25%	Y
2	F	31	H	27.4	AR	E, CS	10	1	-90%	5	0	-100%	N
3	F	34	A	33.6	FA	E, CS, AH	17	6	-65%	10	4	-60%	N
4	F	40	W	21.2	--	E, CS	5	0	-100%	8	0	-100%	N
5	F	65	W	11.9	Dyslipid.	E	5	0	-100%	4	0	-100%	Y
6	F	70	W	16.2	CD, DA	E, CS, AH, Ω3	4	0	-100%	2	0	-100%	N
7	M	19	H	58.9	AS	E, CS	15	4	-73%	5	1	-80%	N
8	F	43	W	40.1	--	E, CS	13	12	-8%	5	4	-20%	Y
9	F	19	A	17.2	--	E, CS	4	4	0%	2	0	-100%	U
10	F	55	W	40.5	FA	E, CS, CI	9	5	-44%	3	0	-100%	N
			Mean	*29.5*	--	--	*9.3*	*4.1* **	*-59.8%* ***	*5.1*	*1.6* **	*-78.5%*	--

Demographics Pediatric Cohort				IgE		PMHx	Home AD Regimen	SCORAD			Pruritus			FHx
Patient	Sex	Age	Race	Pre	Post			Pre	Post	Change	Pre	Post	Change	
P1	F	9	W	26.2	16.8	AR	E, CS, AH	12.8	7.9	-38.3%	3.5	1	-71.4%	Y
P2	M	14	W	381	360	FA	E, CS, AH	34.3	16.1	-53.1%	8	3	-62.5%	N
P3	F	10	W	1163	1256	AS, FA, AR	E, CS, AH	37.7	0	-100%	7.5	0	-100%	N
P4	F	10	H	4.5	3.9	AS, AR	E, CS	23.3	0	-100%	7.5	0	-100%	N
P5	F	9	W	6920	4855	AS, FA, AR	E, CS, AH	48.1	19.1	-60.3%	5	2	-60%	N
			Mean	*8495*	*6492*	--	--	*31.2*	*8.62* *	*-70.3%*	*6.3*	*1.2* **	*-78.8%*	--

Table S2: Patient demographics and treatment response. Demographic, past medical history (PMHx), home regimen, pre and post-treatment antecubital SCORAD values, subjective pruritus scores, presence of family history of AD persisting into adulthood (FHx) are shown for all participants. A = asthma, FA = food allergy, AR = allergic rhinitis, CD = contact dermatitis, DA = drug allergy, Dislipid = dyslipidemia. E = emollients, CS = corticosteroids, AH = antihistamine, Ω3 = omega-3 fatty acid, and CI = calcineurin inhibitors. W = white/Caucasian, H = Hispanic, and A = Asian or Asian Pacific Islander. F = female, M = male, Y = yes, N = no, U = unknown. Note, pruritus scores indicate reported score for total body while antecubital SCORAD represents objective intensity plus pruritus score for antecubital region only. Statistical significance in pre- versus post-treatment values determined by two-tailed Student t test and non-parametric Wilcoxon matched-pairs. * = p value <0.05, ** = p value <0.01, *** = p < 0.001.