Observational study on the palatability and tolerability of oral prednisolone and oral dexamethasone in children in Saudi Arabia and the United Kingdom

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Abstract

Background: Short-course oral corticosteroids are routinely used to treat acute asthma and croup. We evaluated their tolerability and palatability in Saudi Arabian (SA) and UK children.

Methods: Prospective observational/interview study (three months in each country). Palatability was evaluated using a five-point facial scale and tolerability by direct questioning of patient/parents.

Results: In SA, of 122 patients (2–10years) recruited: 52 received prednisolone base tablets; 37 prednisolone sodium phosphate syrup; 33 dexamethasone elixir. In the UK, of 133 patients (2–16years): 38 received prednisolone base tablets (mainly crushed and dispersed); 42 prednisolone sodium phosphate soluble tablets; 53 dexamethasone sodium phosphate oral solution.

In both countries dexamethasone had the highest palatability scores (SA mean: 1.97; UK mean: 3) and prednisolone base tablets the lowest (SA mean: 1.12; UK mean: 1.39). Palatability scores improved for all formulations of prednisolone with each subsequent daily dose.

In SA prednisolone base tablets were associated with more nausea (24 vs 7 patients) and vomiting (5 vs 0) than sodium phosphate syrup (P=0.008 and P=0.073 respectively). In the UK vomiting occurred more frequently with prednisolone base (8) than sodium phosphate soluble tablets (2) (P=0.041).

In both centres dexamethasone was associated with less side effects. Vomiting (1 vs 0 patients), nausea (7 vs 3) and abdominal pain (10 vs 8) occurred more with dexamethasone sodium phosphate solution than dexamethasone elixir.

Conclusions: Dexamethasone sodium phosphate solution was the most palatable preparation. Prednisolone base tablets were rated least palatable and were least well tolerated. Palatability scores improved with each dose taken.

Introduction

Corticosteroids are widely used to treat a variety of medical conditions. The palatability and tolerability of medication is an important factor influencing adherence to medication particularly in children. The European Medicines Agency advises that medicinal products should be made in formulations with an acceptable taste for children [1]. Oral corticosteroids often have a bitter taste and are also associated with a wide variety of adverse effects [2]. Tolerability relates to several factors including taste and adverse symptoms such as vomiting, nausea and abdominal pain that can affect quality of life and willingness to continue treatment [3].

A recent systematic review found that gastrointestinal disorders including vomiting, nausea and abdominal pain were the most common side effects of oral corticosteroids given in short courses [4]. In the studies where formulation was discussed prednisolone sodium phosphate solution had a lower risk of vomiting than both prednisolone (base) solution and oral dexamethasone [4]. Only one study, compared both the palatability and tolerability of oral prednisolone and dexamethasone. This study found that dexamethasone was more likely to cause vomiting than prednisolone [5].

We describe a prospective observational study in the paediatric wards of Gurayat General Hospital (GGH) in Saudi Arabia (SA) and Derbyshire Children's Hospital in the UK to evaluate and compare the tolerability and palatability of routinely used preparations of oral prednisolone for asthmatic patients and oral dexamethasone for croup patients.

Methods

The study was conducted in the children's emergency department (ED) of the two hospitals. Children suffering from asthma or croup, prescribed oral prednisolone or dexamethasone and able to understand the study’s palatability scale and communicate their response were approached for consent. The drugs and products administered were in accordance with standard practice in each department. Choice of product and routine care of the patients was unaffected by the study.

In SA, patients were treated with prednisolone base 5mg tablets (Gupisone®, Julphar, United Arab Emirates), prednisolone sodium phosphate 15mg/5mL syrup (Predo®, Jazeera Pharmaceutical Industries, SA) and dexamethasone 0.5mg/5mL elixir (Decadron®, Algorithm pharmaceutical manufacturers, Lebanon). The study was conducted for three months

between 1st February and 30 April 2015 in GGH. It included only children ≤12 years of age as paediatric admissions in SA are limited to this age.

In the UK, children (2–18 years) were treated with prednisolone base 5mg tablets (Prednisolone, Actavis UK Limited, UK), prednisolone sodium phosphate 5mg soluble tablets (Soluble Prednisolone, Amdipharm UK Limited, UK) and dexamethasone sodium phosphate 2mg/5ml solution (Dexamethasone, Focus Pharmaceuticals Ltd, UK). The study was conducted in the children's Accident & Emergency (A&E) department and hospital wards, for three months between 15 September and 21 December 2015.

We used a five-point facial hedonic scale to assess palatability in both countries, as used previously in studies comparing the taste of analgesic and corticosteroid preparations in children [6][7]. The scale was explained to the patient and parent by the researcher who were then asked to rate the palatability of the medication within ten minutes of taking the drug where possible, by pointing to the appropriate face. To evaluate taste in younger patients who were unable to self-report, parents were asked to help in interpreting what their child thought of the taste of the medication.

Tolerability (nausea, vomiting and abdominal pain) as reported by the parent/patients in response to direct questions, was documented 30–60 minutes after each drug administration. To evaluate nausea in younger patients unable to self-report this symptom, their parents were asked if they had observed any change in their child’s wellbeing which suggested them to be experiencing nausea including dizziness, lethargy or being cold and clammy.

Palatability and tolerability ratings were obtained from patients after each dose of medication until the course ended. The researcher contacted the parents by telephone if the patient had been discharged, alternatively parents were given the option to complete the data collection form themselves and return it by post using a prepaid envelope.

The data collection form (DCF) used for each patient was a modification of questions used in two previous studies of acceptability and/or side effects in children receiving short course prednisolone for the treatment of acute asthma [8][9]. (Figure 1)

Percentages and Chi-square testing were used for categorical variables to compare between tastes of different dosage forms and the tolerability of each drug. Categorical data were compared using the Chi-square or Fisher’s exact test where appropriate. The McNemar-Bowker test was used to compare among the same group of patients how the taste score changed between different days. A significance level of $P<0.05$ was accepted as significant for all the tests.

In Saudi Arabia, ethical approval (Ref: 620/13/54) was obtained from the hospital Quality and Patient Safety Committee (QPSC) on 23 December 2014. In the UK, ethical approval (REC Ref: 15/EM/0057) was obtained from East Midlands - Derby Research Ethics Committee on 19 March 2015.

Results

Overview

In SA, 141 children were approached for the study. 19 children were not recruited: 11 because the parents refused to take part and eight children were missed for observation (Supplement Figure 1). 122 children were enrolled to the study (Table 1). Most of them were asthmatic patients (89) aged 2–10 years and the others had croup (33) aged 2–5.5 years. The asthmatic patients received two formulations of prednisolone (52 received prednisolone base soluble tablets and 37 received prednisolone sodium phosphate syrup). The croup patients all received oral dexamethasone elixir. Prednisolone base tablets were crushed and dispersed in water in all cases. Most patients were aged between 2 and 5 years old. The dose between prednisolone groups was almost the same. Around half of patients in the prednisolone groups had received oral steroids in previous disease episodes, while in the dexamethasone group no patients had oral steroids before.

In the UK, a total of 147 children were approached. 14 children were not recruited: six because the parents refused to take part and eight children were missed for observation (Supplement Figure 2). 133 children were enrolled to the study (Table 1). Most of them were asthmatic patients (80) aged 2–16 years and the others had croup (53) aged 2–10 years. The asthmatic patients received two formulations of prednisolone (38 received prednisolone base tablets and 42 received prednisolone sodium phosphate soluble tablets), and the croup patients all received oral dexamethasone sodium phosphate solution. Crushed prednisolone base tablets and prednisolone sodium phosphate soluble tablets were dispersed/dissolved in water and a few patients followed administration by a drink of blackcurrant juice if the patient chose to when offered this by a nurse. Only five patients received solid prednisolone base tablets. Most patients were aged between 2 and 5 years old in all corticosteroid groups. The dose between prednisolone groups was almost the same. Most patients in the prednisolone groups had received oral steroids previously, while in the dexamethasone group most patients had not received oral steroids before.

Palatability

In SA, the majority of the children on the first day disliked the taste of the medicines (100% of prednisolone base tablet group, 89% of prednisolone sodium phosphate group and 76% of dexamethasone group) and no patients stated that they liked the taste on any day (Table 2). Prednisolone base was disliked the most (89%) and dexamethasone was disliked the least (27%) (P <0.0001). Both prednisolone base tablets and prednisolone sodium phosphate syrup were rated significantly more palatable day by day (Supplement Table 1).

The children who had received oral corticosteroids before (experienced patients), reported different palatability scores to the children who received the medicine for the first time (naïve patients). These differences in taste scores were statistically significant on the first three days (Figure 2).

In the UK, the majority of the children on the first day disliked the taste of the medicines (90% of prednisolone base tablet group, 62% of prednisolone sodium phosphate group and 34% of dexamethasone group) (Table 3). On day 1 most patients that received prednisolone base (77%) disliked the medication very much as did 36% of the prednisolone sodium phosphate group. Only 6% of patients disliked dexamethasone very much (P <0.0001). Both prednisolone base tablets and prednisolone sodium phosphate soluble tablets were rated significantly more palatable day by day (Supplement Table 1).

The children who had received oral corticosteroids before (experienced patients), reported different palatability scores to the children receiving the medicine for the first time (naïve patients). These differences in taste scores were statistically significant on day 3 only (Figure 2). Most treatment naïve croup patients disliked the taste a little (40%) or were neutral (40%), while 33.3% of experienced patients were neutral, 33.3% liked the taste a little and 17% liked the taste very much. The differences were statistically significant (P = 0.021)

Tolerability

In SA, five patients in the prednisolone base group experienced vomiting, while no patients experienced vomiting in the prednisolone sodium phosphate group (P=0.073). Nausea was reported among almost half of patients taking the prednisolone base formulation (24 patients). This was significantly more frequent than with the prednisolone sodium phosphate formulation (OR=3.67, 95% CI, 1.26, 11.58, P=0.008). Abdominal pain, however was reported more frequently in patients taking the prednisolone sodium phosphate formulation (n=13) than in patients taking the prednisolone base formulation (n=8) (OR=2.9, 95% CI, 1.1, 8.1, P=0.031).

The patients who received dexamethasone experienced nausea and abdominal pain at rates of 9% and 24% respectively of the total 33 patients, but no patients experienced vomiting. Other side effects were also reported. Behavioural change and sleep disturbance were the most common side effects. They occurred much more frequently with prednisolone base tablets than prednisolone sodium phosphate syrup, behavioural change (9 vs 2) and sleep disturbance (9 vs 3). The differences were however not significant ($p = 0.11$ and $p = 0.34$ respectively).

In the UK, eight patients in the prednisolone base group and two patients in the prednisolone sodium phosphate group experienced vomiting (P=0.041). Nausea was significantly more frequent being reported by almost half the patients taking the prednisolone base formulation (17) compared to a third of patients taking prednisolone sodium phosphate (11) (OR=2.3, 95% CI, 0.8, 6.5, P=0.103). Abdominal pain was reported more frequently in patients taking the prednisolone base formulation (n=10) than with the prednisolone sodium phosphate formulation (n=7) (OR=1.8, 95% CI, 0.5, 6.3, P=0.413). The patients who received dexamethasone experienced vomiting, nausea and abdominal pain at rates of 1.9%, 13.2% and 18.9% respectively, among the total number of patients (53 patients). Other side effects were also reported. Behavioural change and sleep disturbance were the most common side effects. They occurred more frequently with prednisolone base tablets than prednisolone sodium phosphate soluble tablets, behavioural change (11 vs 9) and sleep disturbance (6 vs 2). The differences were however not significant ($p = 0.45$ and $p = 0.14$ respectively).

Discussion

Taste affects the acceptability of medication and may affect adherence. In these two countries children consistently reported that dexamethasone tasted better than prednisolone; prednisolone base tasted the worst and prednisolone sodium phosphate was more palatable than prednisolone base. Others have also demonstrated differences in the palatability of different formulations [10][11].

Nausea and vomiting were more frequent with prednisolone base tablets in both countries. Prednisolone sodium phosphate syrup resulted in more abdominal pain in the SA children. Others have demonstrated increased vomiting with prednisolone base tablets [10]. This variation of reported side effects shows that the formulation is important. Most children in both countries required the prednisolone base tablets to be dispersed in water prior to administration as they could not swallow whole tablets. This may have reduced the tolerability.

Children in both countries who received dexamethasone were more likely to experience abdominal pain rather than nausea and vomiting. A previous meta-analysis also found that vomiting was more frequent with prednisolone compared with dexamethasone [4].

If improved taste and less side effects were the only deciding factors, prednisolone sodium phosphate would appear to be the best choice for asthmatic children of the commonly used medications but other factors also need to be considered. Oral dexamethasone has been shown to be an effective alternative to oral prednisolone in the treatment of acute asthma in children [12]. Keeney at al suggested that two days of oral dexamethasone is similarly effective to five days of oral prednisolone with evidence that dexamethasone might be better tolerated and require shorter duration of therapy [13]. Since dexamethasone was the overall most palatable and best tolerated preparation when given as a single dose for croup this may suggest that it would be a useful alternative in the treatment of children with acute asthma episodes.

Another factor which must also be considered is the cost of the medication with prednisolone sodium phosphate tablets costing sixty times more than prednisolone base tablets in the UK (Supplement Table 2) [14]. As a result many centres in the UK have moved to using prednisolone base tablets despite patients finding them less palatable and tolerable. Annual cost savings of up to £44,000 in a single UK hospital have been predicted [15].

Taste ratings improved throughout the duration of the treatment. In addition children who had received oral corticosteroids before (experienced patients) reported significantly higher (more favourable) palatability scores than children who received the medicine for the first time (naïve patients) in both countries studied. Research suggests that the physiology and neurobiological mechanisms underlying the taste function mean that the impression of taste changes with time and experience and leads to adaptation of taste perception [16]. The experienced patient who is familiar with the medication taste may therefore have adapted and started to accept it. This may also explain our findings that the taste ratings of all medications improved in both countries day by day. It is also possible that as treatment becomes effective and children start to feel better they become more cooperative and tolerant. No other studies identified however have made this observation of increased tolerability with time or with experience for these drugs.

In conclusion dexamethasone was rated more palatable than prednisolone. For asthmatic patients, prednisolone base tablets were rated the least palatable preparation and were also the least well tolerated. Prednisolone sodium phosphate was associated with a significantly lower incidence of nausea and vomiting and better taste score, compared to prednisolone

base. Best practice suggests prednisolone sodium phosphate or dexamethasone should be used.

Contributorship Statement

FA, IC and SC conceived the idea and designed the study as part of FA's PhD. FA did the data collection and analysed the data and wrote the first draft. MA, IC and SC reviewed and validated the data and revised the paper.

Registration number

None

Study Coordinating Centre:

Paediatric Medicines Research Group, Division of Medical Sciences & Graduate Entry Medicine, School of Medicine, Faculty of Medicine & Health Sciences, University of Nottingham, Royal Derby Hospital Centre (RDH).

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Competing interests

None

What is already known on this topic?

- Oral prednisolone and dexamethasone are widely used in children to treat conditions such as asthma and croup.
- The taste of prednisolone in particular is an issue which may affect adherence to treatment in children.

What this study adds

- Dexamethasone was rated as more palatable than prednisolone in two different countries.
- Prednisolone sodium phosphate seems to cause significantly less nausea and vomiting than prednisolone base and is rated more palatable.
- Experienced patients gave better taste scores for all formulations compared with naïve patients.

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Figure 1 **Data collection form**

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Title of Study: Tolerability of prednisolone and dexamethasone in children

Data collection form

Code

Date		
Sex	M	F
Age		
Weight		
Parental telephone number		
Has child received steroids before?	Yes	No
If yes: how many courses?		

Oral corticosteroid type:

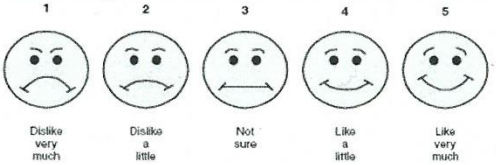
1. Prednisolone ☐
2. Dexamethasone ☐

Dose .....
Period .....
Formulation.....

Administration successful

Yes ☐ .....
No ☐

Swallowing and taste of medication: Did the child



Day	1	2	3	4	5
1. Dislike very much					
2. Dislike a little					
3. Not sure					
4. Like a little					
5. Like very much					

Vomiting: Since starting medication, has the child

	Day 1	Day 2	Day 3	Day 4	Day 5
Never vomited					
Vomited once					
Vomited more than once					
Vomited and treatment stopped					

Nausea: Since starting medication has the child experienced

	Day 1	Day 2	Day 3	Day 4	Day 5
No nausea					
A little nausea					
Severe nausea					

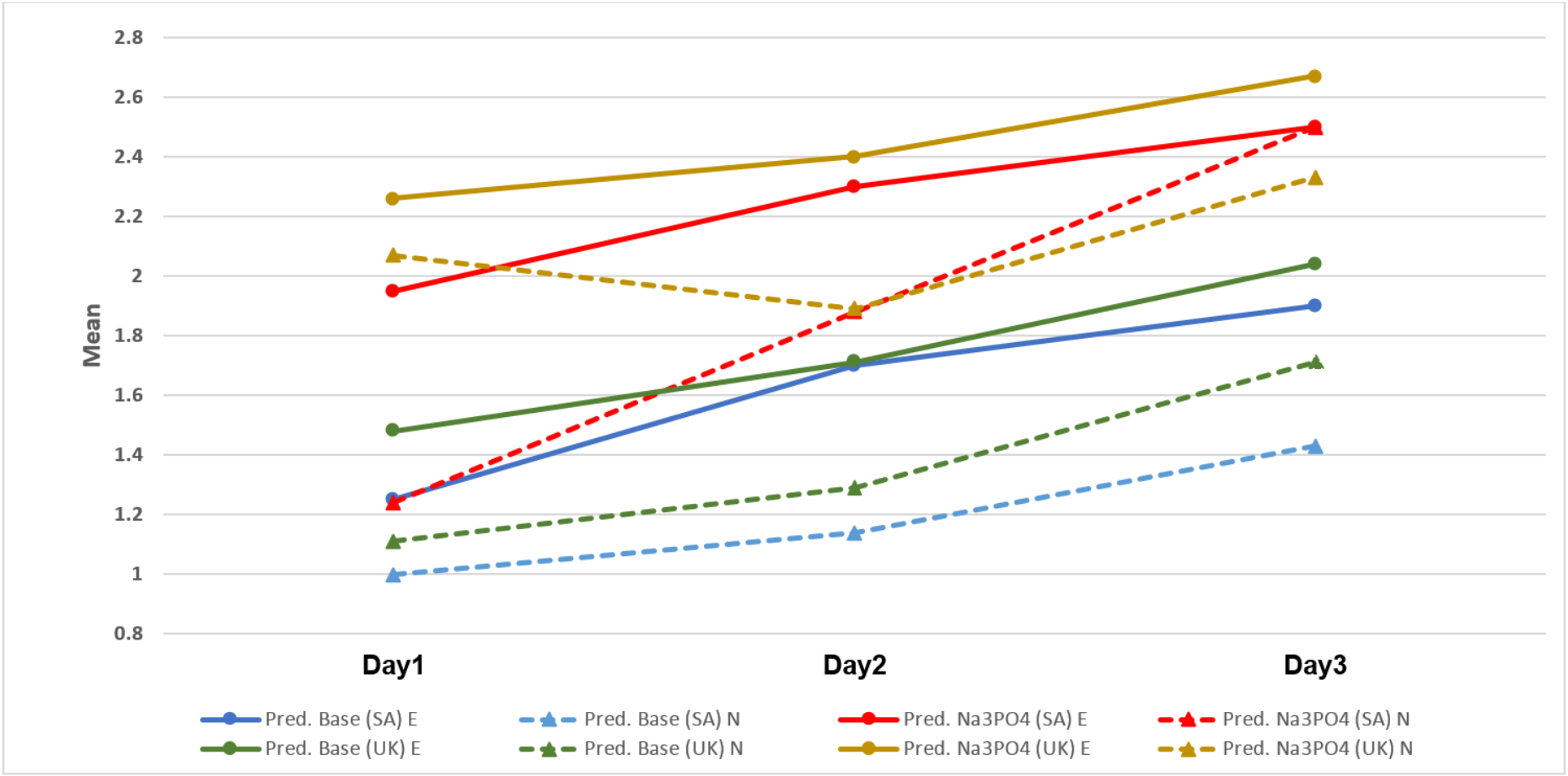
Abdominal (tummy) pain: Since starting medication has the child experienced

	Day 1	Day 2	Day 3	Day 4	Day 5
No abdominal pain					
A little abdominal pain					
Severe abdominal pain					

Other side effects .....

Data collection form (Final version 1.0 Date: 17/12/14)

Figure 2: Mean taste scores of prednisolone base and prednisolone sodium phosphate according to drug history in SA and in the UK



Abbreviations: Pred. Base= prednisolone base, Pred. Na3PO4= prednisolone sodium phosphate, E=Experienced patients, N=Naïve patients.

Table 1 Demographics of recruited children

Total no. of Patients N = 255		SA			UK		
		Prednisolone Base Tablet N = 52	Prednisolone Sodium Phosphate Syrup N = 37	Dexamethasone Elixir N = 33	Prednisolone Base Tablet N = 38	Prednisolone Sodium Phosphate Soluble Tablet N = 42	Dexamethasone Sodium Phosphate Solution N = 53
Age (year)	Median	4.5	4	3.5	5	4	3
	Range	(2 – 10)	(2 – 10)	(2 – 5.5)	(2.4 – 16)	(2 – 14)	(2 – 10)
	Interquartile Range (IQR)	3 – 6	3 – 5	3 – 4.75	3.38 – 7.5	3 – 7	2.5 – 5
Gender	Male (%)	34 (65.4)	18 (48.6)	18 (54.5)	22 (58)	29 (69)	28 (53)
	Female (%)	18 (34.6)	19 (51.4)	15 (45.5)	16 (42)	13 (31)	25 (47)
Weight (kg)	Median	18	15	14	20	17.8	17
	Range	(10 – 35)	(10 – 30)	(10 – 21)	(11.5 – 77)	(10.3 – 80)	(12 – 48.7)
Dose (mg/kg/day)	Median	2	2	0.3	1.2	1.1	0.2
	Range	(1.5 – 2)	2	(0.2 – 0.4)	(1.2 – 2)	(0.4 – 2)	(0.1 – 0.6)
Dose Duration (day)	Median	3	3	1	3	3	1
	Range	(1 – 5)	(3 – 5)	1	(1 – 5)	(1 – 5)	1
Received oral steroids before	Yes	24	20	0	29	27	18
	No	28	17	33	9	15	35

Table 2 Palatability of oral corticosteroids in SA

Total no. of Patients N = 122			N	Taste of medication			Mean of taste score (1-5)¶	S.D.	95% Confidence Interval for Mean	P-value
				Dislike very much (%)	Dislike a little (%)	Not sure or neutral (%)				
Day 1	N = 122	Prednisolone base	52	46 (89)	6 (11)	0	1.12	0.32	(1.03, 1.21)	<0.0001*±
		Prednisolone Sodium Phosphate	37	18 (49)	15 (40)	4(11)	1.62	0.68	(1.39, 1.85)	
		Dexamethasone	33	9 (27)	16 (49)	8 (24)	1.97	0.73	(1.71, 2.23)	
Day 2	N = 82	Prednisolone base	45	29 (64)	13 (29)	3 (7)	1.42	0.62	(1.24, 1.61)	<0.0001*
		Prednisolone Sodium Phosphate	37	4 (11)	25 (68)	8 (21)	2.11	0.57	(1.92, 2.30)	
Day 3	N = 74	Prednisolone base	42	17 (40)	22 (53)	3 (7)	1.67	0.61	(1.48, 1.86)	<0.0001*
		Prednisolone Sodium Phosphate	32	1 (3)	18 (56)	13 (41)	2.38	0.55	(2.18, 2.57)	
Day 4	N = 11	Prednisolone base	10	1 (10)	7 (70)	2 (20)	2.1	0.57	(1.69, 2.51)	0.364±
		Prednisolone Sodium Phosphate	1	0	0	1 (100)	3	-	-	
Day 5	N = 5	Prednisolone base	5	0	3 (60)	2 (40)	2.4	0.54	-	-

* Significant results, ± Fisher's exact test. ¶ 1=Dislike very much, 2=Dislike a little, 3=Not sure, 4=Like a little, 5=Like very much

Table 3 Palatability of oral corticosteroids in the UK

Total no. of Patients N = 133			N	Taste of medication					Mean of taste score (1-5)¶	S.D.	95% Confidence Interval for Mean	P-value
				Dislike very much (%)	Dislike a little (%)	Not sure or neutral (%)	Like a little (%)	Like very much (%)				
Day 1	N = 133	Prednisolone base	38	29 (77)	5 (13)	2 (5)	2 (5)	0	1.39	0.82	(1.12, 1.67)	<0.0001*
		Prednisolone Sodium Phosphate	42	15 (36)	11 (26)	10 (24)	5 (12)	1 (2)	2.19	1.1	(1.84, 2.54)	
		Dexamethasone	53	3 (6)	15 (28)	20 (38)	9 (17)	6 (11)	3	1.1	(2.7, 3.3)	
Day 2	N = 55	Prednisolone base	31	19 (61)	6 (20)	5 (16)	1 (3)	0	1.61	0.88	(1.29, 1.94)	0.009*
		Prednisolone Sodium Phosphate	24	4 (17)	14 (58)	4 (17)	1 (4)	1 (4)	2.21	0.93	(1.81, 2.6)	
Day 3	N = 55	Prednisolone base	31	13 (42)	8 (26)	8 (26)	2 (6)	0	1.97	0.98	(1.61, 2.33)	0.019*
		Prednisolone Sodium Phosphate	24	1 (4)	13 (54)	7 (30)	2 (8)	1 (4)	2.54	0.88	(2.71, 2.91)	
Day 4	N = 9	Prednisolone base	6	3 (49)	1 (17)	1 (17)	1 (17)	0	2	1.27	(0.67, 3.33)	0.131
		Prednisolone Sodium Phosphate	3	0	3 (100)	0	0	0	2	-	-	
Day 5	N = 9	Prednisolone base	6	3 (49)	1 (17)	1 (17)	1 (17)	0	2	1.27	(0.67, 3.33)	0.131
		Prednisolone Sodium Phosphate	3	0	3 (100)	0	0	0	2	-	-	

* Significant results. ¶ 1=Dislike very much, 2=Dislike a little, 3=Not sure, 4=Like a little, 5=Like very much.

Supplement Table 1 **Palatability changes with days of treatment**

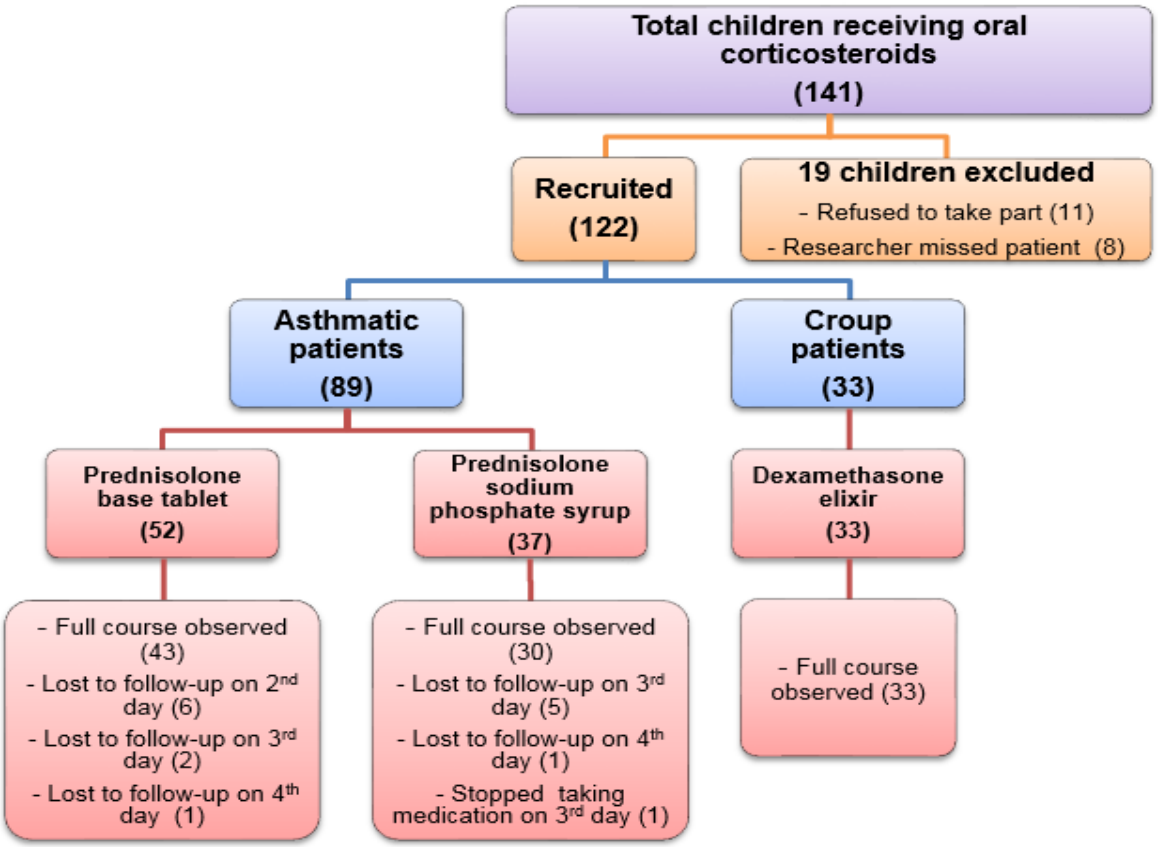
Compare Days	Prednisolone base				Prednisolone Sodium Phosphate			
	SA		UK		SA		UK	
	Mean of taste	P-value	Mean of taste	P-value	Mean of taste	P-value	Mean of taste	P-value
Day 1 vs Day 2	1.12 vs 1.42	0.025*	1.39 vs 1.61	0.061	1.62 vs 2.11	0.001*	2.19 vs 2.21	0.075
Day 2 vs Day 3	1.42 vs 1.67	0.004*	1.61 vs 1.97	0.019*	2.11 vs 2.38	0.075	2.21 vs 2.54	0.136
Day 1 vs Day 3	1.12 vs 1.67	<0.0001*	1.39 vs 1.97	0.01*	1.62 vs 2.38	<0.0001*	2.19 vs 2.54	0.0451*

* Significant results, McNemar-Bowker test.

Supplement Table 2 UK cost of different corticosteroid formulations

Oral corticosteroids (Drug Tariff price) [14]		**Price / unit**	**Treatment cost of one dose for child weighing 20kg receiving 2mg/kg/day of prednisolone or 0.3mg/kg/day of dexamethasone**
Prednisolone base	**Prednisolone 5mg tablets**	**3p/tablet**	**£0.24**
	Prednisolone 5mg/5ml oral solution unit dose	**23p/ml**	**£9.20**
	Prednisolone 10mg/ml oral solution sugar free	**£1.85/ml**	**£7.40**
Prednisolone sodium phosphate	**Prednisolone 5mg soluble tablets**	**£1.78/tablet**	**£14.24**
Dexamethasone	**Dexamethasone 2mg soluble tablets sugar free**	**68p/tablet**	**£2.04**
	Dexamethasone 2mg tablets	**98p/tablet**	**£2.94**
	Dexamethasone 10mg/5ml oral solution sugar free	**63p/ml**	**£1.89**
	Dexamethasone 2mg/5ml oral solution sugar free	**28p/ml**	**£4.20**

Supplement Figure 1 **Enrolment chart for Saudi Arabia children**



Supplement Figure 2 **Enrolment chart for United Kingdom children**