

Oral health assessment in children hospitalised in non-surgical paediatric wards: a prospective cohort study and development of a structured inpatient oral health management protocol

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Abstract

Objectives

To evaluate oral health status, hygiene and dietary habits in children admitted to non-surgical paediatric wards, to investigate the association between pharmacological burden and oral health condition and to propose a structured protocol for inpatient oral health management.

Materials and Methods

This analysis was conducted within a larger study at the Istituto di Ricerca e Cura a Carattere Scientifico (IRCCS) Istituto Giannina Gaslini, Genoa, Italy. Children aged 0–17 years admitted to non-surgical paediatric wards for at least three nights underwent oral examinations at admission (T0) and discharge (TD). Clinical assessment included the Plaque Index (PI), Modified Gingival Index (MGI), Decayed, Missing and Filled Teeth Index (dmft/DMFT), and salivary pH. Caregivers completed validated questionnaires on oral health-related quality of life, oral hygiene practices, dietary habits and pharmacological therapies.

Results

A total of 266 children were enrolled; 241 completed follow-up. During hospitalisation, oral hygiene practices significantly deteriorated, including reduced toothbrushing and fluoride toothpaste use (both $p < 0.001$), whereas plaque accumulation, gingival inflammation and caries experience remained unchanged. Greater pharmacological burden was significantly associated with increased plaque accumulation ($p = 0.015$). Only a minority of patients received oral health counselling or dental assessment during hospitalisation.

Conclusion

Hospitalisation was associated with deterioration of oral hygiene behaviours, reinforcing the need for structured preventive oral care pathways in routine paediatric inpatient management.

Clinical Relevance:

Hospital admission provides an opportunity to identify unmet oral health needs, promote preventive oral care and implement multidisciplinary protocols to improve oral health outcomes in medically vulnerable children.

Introduction

Children admitted to non-surgical paediatric wards represent a vulnerable population, frequently exposed to conditions that may negatively affect oral health [1, 2]. Prolonged pharmacological therapies, changes in dietary habits, reduced autonomy in self-care and disruption of daily oral hygiene routines during hospitalisation may contribute to the development or exacerbation of oral diseases and discomfort [3].

Despite this, oral health assessment and preventive oral care are rarely integrated into routine paediatric inpatient management [3, 4].

Several medications commonly prescribed in paediatric medical wards are associated with oral adverse effects. Sugar-containing formulations may increase the risk of dental caries, particularly when administered repeatedly throughout the day [5, 6]. In addition, antiepileptics, corticosteroids, antibiotics, psychotropic medications and immunosuppressive agents may alter the oral environment by inducing xerostomia, gingival enlargement, dysbiosis, opportunistic infections, mucosal lesions and taste disturbances [7–9].

These effects may be particularly relevant in children with chronic or medically complex conditions, who frequently require long-term multidrug therapies and repeated hospitalisations [10, 11]. Despite this, oral assessment is rarely integrated into routine inpatient evaluation and structured oral care protocols for general paediatric wards remain limited [4]. Existing recommendations are mainly restricted to selected high-risk populations, such as oncology or intensive care patients, while little attention has been dedicated to children hospitalised in other medical wards [12–14].

Hospitalisation may therefore represent both a challenge and an opportunity for oral health management. Acute illness, caregiver stress and the prioritisation of systemic care often reduce attention to daily oral hygiene, whereas the inpatient setting provides an opportunity to identify untreated oral conditions, recognise medication-related oral complications, and promote preventive interventions through multidisciplinary collaboration [1–3].

Improving the integration of oral health into paediatric inpatient care requires a better understanding of the oral health needs of hospitalised children and the factors associated with oral deterioration during admission.

The primary aim of this study was to evaluate oral health status, oral hygiene behaviours, dietary habits, oral health-related quality of life (OHRQoL) and the association between pharmacological burden and oral health in children admitted to non-surgical paediatric wards, assessing changes occurring between hospital admission and discharge. A secondary aim was to propose a structured oral health management protocol to support the integration of oral assessment and preventive care into routine paediatric inpatient practice.

Materials and methods

Study Design and Setting

The present observational study was conducted at the Istituto di Ricerca e Cura a Carattere Scientifico (IRCCS) Istituto Giannina Gaslini (Genoa, Italy) as a part of a broader project investigating the impact of hospitalisation on paediatric oral health and supporting the development of ward-specific oral health management protocols.

Participants

Children aged 0–17 years consecutively admitted to non-surgical wards between 6 November 2023 and 30 April 2025 and expected to remain hospitalised for at least three nights were eligible for inclusion.

Patients were excluded if oral examination could not be completed because of poor cooperation, if no parent or caregiver was available at enrolment, or if admission was for emergency care, day-hospital procedures, or dental treatment.

The present analysis specifically focused on children admitted to the endocrinology, gastroenterology, nephrology, neurology, pneumology and rheumatology wards.

Children admitted to the oncology–haematology, bone marrow transplantation and cardiology were excluded, as these patients present systemic conditions known to markedly affect oral health and will be investigated separately. Patients admitted to surgical wards and neuropsychiatry were excluded, as these groups were evaluated separately for the development of ward-specific oral care protocols [15]. These exclusions were intended to obtain a more homogeneous study population.

The study was conducted in accordance with the Declaration of Helsinki and all relevant guidelines and regulations. The study protocol was approved by the Liguria Territorial Ethics Committee (Comitato Etico Territoriale Liguria, CET Liguria) prior to participant recruitment (approval No. 294/2023-DB, ID 13233; 2 October 2023). Written informed consent was obtained from the parents or legal guardians of all participants, as all participants were minors. Age-appropriate assent was also obtained from the children whenever possible.

Data collection

Baseline assessments (T0) were performed within 24 hours of admission. Caregivers completed structured questionnaires collecting information on medical history, previous hospitalisations, chronic diseases, pharmacological therapies, dietary habits, oral hygiene practices and previous dental care. Clinical information was integrated with data retrieved from the electronic medical records (Galileo e-health.solutions NOEMALIFE®, Bologna, Italy). A detailed overview of all collected variables is provided in the Supplementary Materials (Supplementary Table S1).

At hospital discharge (TD), medical records were reviewed to document newly identified diagnoses and pharmacological therapies introduced throughout hospitalisation. Caregivers completed a follow-up questionnaire investigating changes in dietary habits and oral hygiene practices during the hospital stay, as well as the provision of dietary counselling, oral hygiene instructions and dental assessment. A detailed summary of the collected variables is available in the Supplementary Materials (Supplementary Table S2).

Clinical assessment

Bedside oral examinations were performed at admission and discharge by three dental practitioners following a standardised assessment protocol. Before the beginning of the study, the examiners carried out preliminary joint evaluations on a small number of patients to harmonise the interpretation of the diagnostic criteria and standardise the examination procedures. All oral examinations were carried out directly within the hospital wards. According to the patient's clinical condition, assessments were performed either with the child positioned in the hospital bed or seated upright in a chair. A portable light source was used to provide adequate illumination and standard dental instruments, including a mouth mirror and dental probe, were employed for the clinical evaluation.

The clinical assessment included dental caries experience using the Decayed, Missing and Filled Teeth Index for both primary and permanent dentitions (dmft/DMFT) [16], gingival health using the Modified Gingival Index (MGI)[17], orthodontic treatment need using the Index of Orthodontic Treatment Need (IOTN) [18], plaque accumulation using the O'Leary Plaque Index (PI) [19] following application of a plaque-disclosing agent. The percentage of tooth surfaces covered by plaque was calculated and classified into four categories: low (0–25%), moderate (26–50%), high (51–75%), and very high (76–100%). Salivary pH was measured using colourimetric indicator strips.

All clinical assessments were performed at least one hour after the patient's last meal, while salivary pH was assessed only after a minimum fasting period of two hours. To minimise behavioural bias, no oral hygiene or dietary advice was provided during the study assessments. Individual feedback on the child's oral health status was given verbally to caregivers only after completion of the discharge assessment.

Oral Health-Related Quality of Life (OHRQoL) assessment

OHRQoL was assessed at baseline using validated age-specific questionnaires. Caregivers of children younger than 6 years completed the Early Childhood Oral Health Impact Scale (ECOHIS), whereas caregivers of older children completed the short version of the Parental-Caregiver Perceptions Questionnaire (P-CPQ) together with the Family Impact Scale (FIS) [20, 21]. Caregivers also rated their child's overall oral health and its perceived impact on general well-being using five-point Likert scales ranging from "not at all" to "very significantly".

Pharmacological burden

Baseline pharmacological therapy was recorded according to the number of medications, treatment duration, pharmacological class, active ingredient, route of administration and pharmaceutical formulation. Patients were categorised into four groups according to pharmacological burden: no medication, monotherapy, two to four medications, and more than four medications. Vitamins and dietary supplements were included in the medication count. Oral adverse effects, potentially related to pharmacological therapies, either present at baseline or previously experienced, were also collected.

Changes in pharmacological therapy during hospitalisation were documented at discharge, excluding medications administered for general anaesthesia. Reported oral adverse effects potentially related to medications were descriptively analysed and compared with those described in the literature. The frequency of pharmacological classes and active ingredients was evaluated to support the development of ward-specific preventive oral health protocols. Finally, the study explored whether patients adopted precautionary oral hygiene measures following medication intake.

Statistical analysis

Means and standard deviations were used to describe normal variables, whereas medians and interquartile ranges (IQR) were reported for non-normally distributed quantitative variables. Normality was assessed by visual inspection of the related histograms. Absolute frequencies and percentages were used to describe categorical variables.

For independent groups, continuous variables were compared using the Mann-Whitney U test (for two groups) or the Kruskal-Wallis test (for three or more groups). Association between categorical variables was assessed by the chi-square test or the Fisher's exact test, as appropriate.

Continuous variables measured at hospital admission and discharge were compared using the Wilcoxon signed-rank test for paired samples. The non-parametric approach was used due to the non-normal distribution of most variables considered. Categorical variables were analysed using the Stuart–Maxwell test for marginal homogeneity in paired data. A two-sided p-value < 0.05 was considered statistically significant. All analyses were performed by STATA/MP 18.0 statistical software (StataCorp LLC, College Station, TX, USA).

Results

Study population

A total of 266 children admitted to non-surgical paediatric wards were enrolled at baseline (T0). The study population included patients admitted to the endocrinology (22.2%), gastroenterology (15.8%), nephrology (12.0%), neurology (18.4%), pneumology (16.2%) and rheumatology (15.4%) wards. Admission and discharge assessments was completed by 241 patients (90.6%), who were included in the longitudinal analysis. Nine patients (3.4%) were transferred to another ward during hospitalisation, mainly because of clinical needs.

Baseline characteristics

Detailed demographic and clinical characteristics of the study population, including age and sex distribution, are reported in Table 1.

Table 1
Characteristics of 266 hospitalised patients.

Patient characteristics	N	%
Hospital wards		
Endocrinology	59	22.2
Gastroenterology	42	15.8
Nephrology	32	12.0
Neurology	49	18.4
Pneumology	43	16.2
Rheumatology	41	15.4
Age (years)		
< 1	2	0.8
1–5	74	27.8
6–11	98	36.8
12–17	92	34.6
Gender		
Males	127	47.7
Females	139	52.3
Diagnosis of systemic disease at T0		
No	41	15.4
Yes	225	84.6
Baseline pharmacologic therapy		
No	82	30.8
Yes	184	69.2
In-hospital pharmacologic therapy* (n = 241**)		
No	122	50.6
Yes	119	49.4
Length of hospitalisation (days) (n = 241**)		
3	82	34.0
* Excluding medication for general anaesthesia, ** patients who completed T0 and TD assessments		

Patient characteristics	N	%
4–15	147	61.0
15–30	12	5.0
* Excluding medication for general anaesthesia, ** patients who completed T0 and TD assessments		

Oral hygiene and dietary habits at admission

At-home oral hygiene and dietary habits are summarised in Table 2. Oral hygiene was reported by 93.2% of participants, although only 17.3% brushed their teeth three or more times daily. Toothbrush use was almost universal among children performing oral hygiene, whereas additional oral hygiene devices were infrequently used (13.3%). Caregiver awareness of fluoride toothpaste was limited (36.7%). Cariogenic dietary habits were common, with regular consumption of cariogenic foods and beverages reported by 90.0% and 62.9% of patients, respectively. Previous dental attendance was reported by 71.8% of children, whereas only 35.0% had undergone professional oral hygiene procedures.

Table 2
Dental history, cariogenic habits, and oral hygiene practices of the patients at the time of hospitalisation (T0).

Patient characteristics	N	%
Oral hygiene at home		
No	18	6.8
Yes	248	93.2
Frequency of daily oral care at home (N = 248)		
1	64	25.8
2	141	56.9
3	39	15.7
> 3	4	1.6
Any toothbrush [§] (N = 248)		
No	3	1.2
Yes	245	98.8
Manual toothbrush [§] (N = 248)		
No	70	28.2
Yes	178	71.8
Electric toothbrush [§] (N = 248)		
No	157	63.3
Yes	91	36.7
Other oral care supplies [§] (N = 248)		
No	215	86.7
Yes	33	13.3
Fluoride knowledge [§] (N = 248)		
No	157	63.3
Yes	91	36.7
Consumption of cariogenic foods (N = 259)*		
No	26	10.0

Patient characteristics	N	%
Yes	233	90.0
Consumption of cariogenic beverages (N = 259)*		
No	96	37.1
Yes	163	62.9
Number of meals per day (N = 259) *		
< 3	2	0.8
3	34	13.1
4	80	30.9
5	90	34.8
> 5	53	20.5
Previous dental attendance		
No	75	28.2
Yes	191	71.8
Previous professional oral hygiene sessions		
No	173	65.0
Yes	93	35.0

§ Analysis carried out only on the 248 patients who reported performing oral hygiene practices at home. * 7 patients not applicable (enteral/parenteral nutrition).

Baseline oral health status

Baseline clinical findings are reported in Table 3. Overall, 40.2% of patients presented good or very good oral health, whereas 20.3% were classified as having poor oral health. Caries experience was observed in 42.3% of the cohort (mean dmft/DMFT 2.03 ± 3.37 , median 0.0, IQR 0.0–3.0). Most children showed mild-to-moderate gingival inflammation, while moderate-to-very-high plaque accumulation was observed in approximately two-thirds of the study population. Oral pain was reported by 12.4% of participants.

Table 3
Clinical oral and dental examination of patients at the time of hospitalisation (T0).

Patient characteristics	N	%
Global assessment of oral health status		
Poor	54	20.3
Sufficient	36	13.5
Fair	69	25.9
Good	72	27.1
Very good	35	13.2
Caries experience*		
No	153	57.7
Yes	112	42.3
MGI *		
0	40	15.1
1	103	38.9
2	88	33.2
3	29	10.9
4	5	1.9
Plaque Index #		
Low	84	33.7
Moderate	75	30.1
High	33	13.3
Very high	57	22.9
Oral pain		
No	233	87.6
Yes	33	12.4
* 1 patient not/applicable (edentulous) # 17 missing values due to patient-related inability to use the plaque-disclosing agent		

Pharmacological burden and oral health

At admission, 69.5% of patients were receiving at least one background therapy, and 52.3% were treated with two or more drugs. Patients were classified according to pharmacological burden as follows: no medication (30.5%), monotherapy (17.3%), two to four medications (40.2%), and more than four medications (12.0%).

The association between pharmacological burden and baseline oral health is shown in Table 4. No significant associations were observed between pharmacological burden and global oral health status, caries experience, IOTN, gingival inflammation, oral pain, or salivary pH. In contrast, plaque accumulation was significantly associated with the number of medications ($p = 0.015$), with a stronger association when plaque index was analysed as a continuous variable ($p < 0.001$). Salivary pH was not associated with the number of treatments ($p = 0.121$, data not shown).

Table 4
Number of medications in background therapy at T0 and oral health status indices

Patient characteristics	0		1		2–4		> 4		<i>p</i>
	N	%	N	%	N	%	N	%	
Global assessment of oral health status									0.346
Poor	13	16.1	7	15.2	28	26.2	6	18.8	
Sufficient	10	12.4	6	13.0	14	13.1	6	18.8	
Fair	19	23.5	10	21.7	30	28.0	10	31.3	
Good	22	27.2	17	37.0	25	23.4	8	25.0	
Very good	17	21.0	6	13.0	10	9.4	2	6.3	
Caries experience*									0.972
No	45	55.6	27	58.7	62	58.5	19	59.4	
Yes	36	44.4	19	41.3	44	41.5	13	40.6	
IOTN [§]									0.204
1	34	52.3	11	29.0	33	41.3	9	36.0	
2	12	18.5	7	18.4	13	16.3	4	16.0	
3	9	13.9	9	23.7	7	8.9	2	8.0	
4	8	12.3	7	18.4	16	20.0	7	28.0	
5	2	3.1	4	10.5	11	13.8	3	12.0	
MGI*									0.311
0	15	18.5	8	17.4	14	13.2	3	9.4	
1–2	60	74.1	34	73.9	75	70.8	22	68.8	
3–4	6	7.4	4	8.7	17	16.0	7	21.9	
Plaque Index [#]									0.015
Low	29	37.7	25	54.4	22	23.2	8	25.8	
Moderate	25	32.5	11	23.9	29	30.5	10	32.3	
* 1 patient not/applicable (edentulous), [§] 58 missing values due to insufficient dentition to assess occlusion or inadequate patient cooperation, [#] 17 missing values due to patient-related inability to use the plaque-disclosing agent									

Patient characteristics	0		1		2–4		> 4		<i>p</i>
	N	%	N	%	N	%	N	%	
High	12	15.6	4	8.7	13	13.7	4	12.9	
Very high	11	14.3	6	13.0	31	32.6	9	29.0	
Oral pain									0.585
No	72	88.9	42	91.3	93	86.9	26	81.3	
Yes	9	11.1	4	8.7	14	13.1	6	18.8	
* 1 patient not/applicable (edentulous), § 58 missing values due to insufficient dentition to assess occlusion or inadequate patient cooperation, # 17 missing values due to patient-related inability to use the plaque-disclosing agent									

A history of oral adverse effects potentially related to pharmacological therapy was reported by nine patients. The reported manifestations included gingival enlargement, xerostomia, sialorrhoea, burning mouth symptoms, aphthous lesions, delayed tooth eruption, tartar formation, and rapid caries onset. These findings were mainly associated with antiepileptic drugs, antihypertensive agents, immunosuppressants, and proton pump inhibitors (Supplementary Table S3). During hospitalisation, two additional patients developed burning tongue, considered potentially related to anxiolytic therapy in one case and combined antibiotic and corticosteroid therapy in the other.

Oral health impact on quality of life

OHRQoL was assessed in a subgroup of 157 patients using age-appropriate validated questionnaires (Supplementary Table S4). Caregivers of 113 children completed the P-CPQ and FIS, whereas the ECOHIS was administered to 44 caregivers of younger children.

No significant association was found between P-CPQ scores and either hospital ward ($p = 0.805$) or the presence of chronic diseases ($p = 0.460$). In contrast, FIS scores differed significantly according to hospital ward ($p = 0.013$), with higher median family impact reported among children admitted to the neurology, endocrinology, and pneumology wards, whereas no association was observed with chronic diseases ($p = 0.189$). ECOHIS scores did not differ significantly across hospital wards ($p = 0.185$). Although children with chronic diseases showed lower ECOHIS scores than those without chronic diseases ($p = 0.025$), this finding should be interpreted with caution because only two participants had no chronic disease.

Changes in oral health status and hygiene habits during hospitalisation

Changes in clinical oral health status, oral hygiene behaviours, and dietary habits during hospitalisation are summarised in Table 5. Oral pain significantly decreased during hospitalisation (11.2% vs. 4.2%; $p =$

0.002), whereas global oral health status, plaque accumulation, and gingival inflammation remained substantially unchanged. Consumption of cariogenic beverages and the number of daily meals significantly decreased during hospitalisation (both $p < 0.001$). Conversely, oral hygiene practices deteriorated, with significant reductions in the proportion of children performing oral hygiene, toothbrush use, and fluoride toothpaste use (all $p < 0.001$).

Oral health promotion during hospitalisation

Dietary counselling was provided to 49 patients (20.3%), mainly by nutritionists and physicians. Only 10 patients (4.2%) received oral hygiene advice from healthcare professionals, and 14 children (5.8%) underwent dental assessment during hospitalisation.

Table 5

Clinical oral examination, dietary habits and oral hygiene practices of 241 patients. Comparison between time of admission (T0) and discharge (TD).

Patient characteristics	Time at the hospitalisation (T0)		Time at the discharge (TD)		<i>p</i> [#]
	N	%	N	%	
Oral health status					0.526
Poor	48	19.9	50	20.8	
Sufficient/Fair	93	38.6	93	38.6	
Good/Very good	100	41.5	98	40.7	
Plaque Index (n = 220)*					0.574
Low	79	35.9	74	33.6	
Moderate	65	29.6	67	30.5	
High	27	12.3	25	11.4	
Very high	49	22.3	54	24.6	
Modified Gingival Index (n = 239)**					0.549
0	37	15.5	36	15.1	
1–2	176	73.6	175	73.2	
3–4	26	10.9	28	11.7	
Oral pain					0.002
No	214	88.8	231	98.9	
Yes	27	11.2	10	4.2	
Consumption of cariogenic foods (n = 232)***					0.239
No	22	9.5	28	12.1	
Yes	210	90.5	204	87.9	
Consumption of cariogenic beverages (n = 232)***					< 0.001
No	86	37.1	115	49.6	
Yes	146	62.9	117	50.4	

Patient characteristics	Time at the hospitalisation (T0)		Time at the discharge (TD)		<i>p</i> [#]
	N	%	N	%	
Number of meals per day (n = 220) [§]					< 0.001
< 3	2	0.9	1	0.5	
3	30	13.6	59	26.8	
4	64	29.1	74	33.6	
5	79	35.9	54	24.6	
> 5	45	20.4	32	14.5	
Hygiene practices (n = 241)					< 0.001
No	15	6.2	54	22.4	
Yes	226	93.8	187	77.6	
Oral care devices (n = 226) ^{§§}					< 0.001
No	0	0.0	25	11.1	
Yes	226	100	201	88.9	
Toothbrush (n = 226) ^{§§}					< 0.001
No	3	1.3	27	11.9	
Yes	223	98.7	199	88.1	
Fluoride toothpaste (n = 226) ^{§§}					< 0.001
No	12	5.3	32	14.2	
Yes	214	94.7	194	85.8	

[#] *p* = *p*-value obtained by the Stuart-Maxwell test for paired samples, * 21 missing values due to patient-related inability to use the plaque-disclosing agent, ** 2 missing values: 1 missing in T0 (edentulous), 1 missing in TD (non-cooperation), *** 9 missing values due to parenteral/enteral nutrition, [§] 18 missing values due to 9 enteral/parental nutrition and 9 missing answers; ^{§§} Analysis performed only on the 226 patients who reported performing oral hygiene during hospitalisation.

Proposed Oral Health Management Protocol for Children Admitted to Non-Surgical Paediatric Wards

Based on the findings of the present study and current evidence on paediatric oral health promotion, a structured oral health management protocol was developed for children admitted to non-surgical paediatric wards. The protocol aims to support preventive oral care before, during and after hospitalisation and should be considered a practical framework requiring future clinical validation. The proposed protocol translates the main findings of the present study into practical recommendations to support the integration of oral health into routine paediatric inpatient care.

1. Pre-admission

Families should receive information on maintaining good oral health before admission.

Patients and caregivers should be advised to:

- Perform toothbrushing at least twice daily using age-appropriate fluoridated toothpaste;
- Maintain regular oral hygiene routines even during periods of illness;
- Schedule a dental examination in the presence of untreated caries, gingival bleeding, oral pain, visible plaque accumulation or other oral health concerns;
- Inform healthcare professionals about ongoing dental treatments or relevant oral symptoms;
- Bring personal oral hygiene supplies to the hospital.

2. Hospitalisation

Oral health assessment

A basic oral health assessment should be performed within the first 24 hours of admission.

The assessment should include:

- Oral hygiene status and plaque accumulation;
- Untreated dental caries;
- Gingival inflammation;
- Oral pain or mucosal lesions;
- Salivary alterations;
- Dental anomalies;
- Current pharmacological therapies;
- Availability of personal oral hygiene devices brought to the hospital.

Children at increased risk or presenting untreated oral disease, persistent oral pain, medication-related oral manifestations or significant plaque accumulation should be referred to paediatric dental services

whenever appropriate. If referral is not immediately feasible, oral findings should be documented and preventive advice provided to ensure continuity of care after discharge.

Daily oral care

Daily oral hygiene should be actively promoted throughout hospitalisation.

Recommendations include:

- Toothbrushing at least twice daily using age-appropriate fluoridated toothpaste;
- Availability of oral hygiene devices throughout the hospital stay;
- Caregiver-assisted oral hygiene whenever necessary, using gauze or moistened oral swabs when toothbrushing is not feasible.

Oral health education and counselling

Brief oral health counselling should be provided to patients and caregivers during hospitalisation and should emphasise:

- Appropriate oral hygiene practices and fluoride use;
- The relationship between oral health and general health, including medication-related oral effects;
- The importance of regular dental attendance;

Pharmacological management

Attention should be given to:

- Polypharmacy;
- Long-term pharmacological therapies;
- Sugar-containing or acidic liquid medications;
- Medications associated with xerostomia or other oral adverse effects (e.g. corticosteroids, antiepileptic drugs and immunosuppressive agents).

Whenever feasible, patients should be encouraged to rinse their mouth with water after medication intake. Adequate hydration and reinforcement of oral hygiene measures should be encouraged in patients receiving multiple or long-term therapies. Any suspected medication-related oral adverse effects should be documented and monitored throughout hospitalisation.

Dietary management

Healthcare professionals should encourage:

- Structured meal schedules;

- Limitation of sugary snacks between meals;
- Reduction of cariogenic beverage consumption;
- Water as the preferred beverage between meals.

3. Discharge

Discharge counselling should include:

- Continuation of twice daily toothbrushing using fluoridated toothpaste;
- Reinforcement of healthy dietary habits;
- Information regarding possible oral adverse effects of prescribed medications;
- Recommendations for routine dental follow-up.

Referral to paediatric dental services should be recommended for children presenting untreated oral disease, persistent oral symptoms, suspected medication-related complications, poor oral hygiene or no dental examination within the previous 6 months.

4. Healthcare staff training

Healthcare professionals should receive structured training on oral health promotion and prevention.

Training programmes should cover recognition of common oral diseases, basic oral health assessment, medication-related oral manifestations, preventive counselling, and referral criteria. Programmes should be updated regularly to ensure consistent implementation.

The main phases and recommendations of the proposed oral health management protocol are summarised in Fig. 1.

Discussion

The present prospective cohort study investigated oral health status, oral hygiene behaviours, dietary habits and pharmacological burden in children admitted to non-surgical paediatric wards. The main findings indicate that hospitalisation was associated with a mild deterioration in oral hygiene-related behaviours, including reduced hygiene practices. In parallel, pharmacological burden was associated with plaque accumulation at admission. Finally, the study highlighted the limited integration of oral health counselling and dental assessment within routine inpatient paediatric care.

A clinically relevant finding was the worsening of oral hygiene behaviours during hospitalisation. Although the overall oral health status remained relatively stable between admission and discharge, the reduction in toothbrushing and fluoride toothpaste use suggests that daily preventive routines are particularly vulnerable during inpatient care. This is consistent with recent evidence showing that oral care in hospitalised children is often overlooked, with barriers including acute illness, fatigue, lack of

supplies, competing medical priorities and insufficient integration of oral care into nursing routines [2, 3, 22]. In paediatric patients, oral hygiene is strongly dependent on caregivers and healthcare staff; therefore, disruption of family routines and the hospital environment may rapidly compromise self-care practices. Although the frequency of oral hygiene practices decreased during hospitalisation, the overall oral health status remained relatively stable between admission and discharge. This suggests that the relatively short length of hospital stay was insufficient to produce measurable changes in oral health.

The reduction in cariogenic beverage intake and number of daily meals observed during hospitalisation may reflect greater dietary control within the hospital setting. This finding is important because it suggests that hospitalisation may create a structured nutritional environment while still failing to adequately support oral hygiene. Similar concerns have been raised in studies evaluating oral health care in hospitalised children, where oral hygiene is frequently perceived as secondary to the management of systemic disease [3, 22]. Therefore, dietary control alone is unlikely to be sufficient unless combined with structured oral hygiene support.

The association between pharmacological burden and plaque accumulation is another relevant finding. Most children in the present cohort had chronic or medically complex conditions and more than half were receiving two or more medications. Children with medical complexity are known to experience higher oral health vulnerability, due to functional limitations, caregiver burden, dietary restrictions, access barriers and frequent exposure to long-term pharmacological therapies [10, 23, 24]. Polypharmacy may contribute to oral health deterioration through both direct and indirect mechanisms, including salivary alterations, gingival changes, mucosal symptoms, taste disturbances and increased complexity of daily care routines. In addition, paediatric liquid medications may present cariogenic or erosive potential because of low pH, sugar content, viscosity and repeated daily administration [5, 6].

Despite the high prevalence of chronic pharmacological therapy, severe medication-related oral manifestations were uncommon in this cohort. Notably, most of the oral findings potentially associated with medications were already present at admission, suggesting that the short duration of hospitalisation is unlikely to have substantially influenced their occurrence. Rather than reflecting acute drug-related effects, these manifestations are more likely to represent the cumulative impact of long-term therapies and their interaction with individual susceptibility and oral hygiene practices. Furthermore, the present study involved a paediatric population, in which the clinical expression of medication-related oral adverse effects may differ from that observed in adults. In contrast, elderly patients receiving long-term pharmacological therapies are frequently exposed to age-related physiological changes, polypharmacy and salivary gland dysfunction, factors that may increase the likelihood and severity of oral complications [25–27]. These differences may partly explain the relatively limited number of medication-related oral manifestations observed in our cohort. Nevertheless, the reported cases of xerostomia, gingival enlargement, sialorrhea, burning symptoms, aphthous lesions and rapid caries onset are consistent with previously described medication-related oral manifestations. Antiepileptic drugs, immunosuppressive therapies, antihypertensive agents, antibiotics, corticosteroids and psychotropic medications have all been associated with oral complications, including gingival

enlargement, salivary dysfunction, mucosal alterations and an increased risk of plaque-related diseases [9, 28, 29].

The limited provision of oral hygiene advice, dietary counselling, and dental assessment during hospitalisation represents one of the most important findings of this study. Only a small proportion of children received oral hygiene counselling or dental evaluation during their inpatient stay. This confirms that oral health remains insufficiently integrated into routine paediatric hospital care, despite increasing recognition of the relationship between oral health, systemic health, quality of life and care burden [3, 24]. Current structured recommendations are mainly available for high-risk populations, such as paediatric oncology, haematology, transplantation and intensive care patients, whereas evidence and protocols for children admitted to general medical wards remain limited [4, 30, 31].

The present study has several limitations. First, the study population was heterogeneous, including children admitted to different medical wards with diverse systemic diseases and pharmacological exposures. This heterogeneity reflects real-life paediatric inpatient care but limits the possibility of attributing oral findings to specific diseases or medications. Second, although pharmacological burden was associated with plaque accumulation, the observational design does not allow causal inference. Third, the duration of hospitalisation was relatively short for most patients, which may have limited the detection of clinically evident changes in caries experience, gingival inflammation, or medication-related oral manifestations. Finally, subgroup analyses by pharmacological class were limited by sample size and by the frequent coexistence of multiple medications.

Despite these limitations, this study provides prospective evidence that children admitted to non-surgical paediatric wards are vulnerable to deterioration in oral hygiene behaviours during hospitalisation and that pharmacological burden may be associated with poorer plaque control. The findings underline the need to move beyond episodic dental consultation and towards structured inpatient oral care pathways.

Conclusions

The findings of the present study support the need for structured oral health management protocols for paediatric inpatients admitted to non-surgical wards. Such protocols should include early oral health assessment at admission, identification of children at increased risk of oral disease, maintenance of daily oral hygiene routines during hospitalisation, caregiver education and timely referral to dental professionals when needed. Importantly, hospitalisation should not be viewed only as a risk period for oral health deterioration, but also as an opportunity to intercept untreated oral conditions, reinforce preventive behaviours and integrate oral health into multidisciplinary paediatric care.

Abbreviations

DMFT

Decayed, Missing and Filled Teeth Index (permanent dentition)

dmft

Decayed, Missing and Filled Teeth Index (primary dentition)

ECOHIS

Early Childhood Oral Health Impact Scale

FIS

Family Impact Scale

IOTN

Index of Orthodontic Treatment Need

IRCCS

Istituto di Ricovero e Cura a Carattere Scientifico

IQR

Interquartile Range

MGI

Modified Gingival Index

OHRQoL

Oral Health-Related Quality of Life

P-CPQ

Parental-Caregiver Perceptions Questionnaire

PI

Plaque Index

T0

Hospital admission (baseline assessment)

TD

Hospital discharge

Declarations

Declarations

The study protocol received approval from the Regional Ethics Committee prior to participant enrolment (Comitato Etico Territoriale Regione Liguria No. 294/2023-DB, ID 13233; approved on 2 October 2023).

Competing interests

The authors declare no competing interests.

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Author Contribution

Conceptualization, C.C. and N.L.; methodology, C.C. and N.L.; software, S.P.; validation, G.R., V.C. and G.T.; formal analysis, S.P.; investigation, G.R., V.C. and G.T.; resources, C.C. and N.L.; data curation, G.R., V.C. and G.T.; writing—original draft preparation, G.R., V.C. and G.T.; writing—review and editing, C.C. and S.P.; visualization, N.L.; supervision, C.C. and N.L.; project administration, N.L.; funding acquisition, N.L.; statistical analysis S.P. All authors have read and agreed to the published version of the manuscript.

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Data Availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Figures

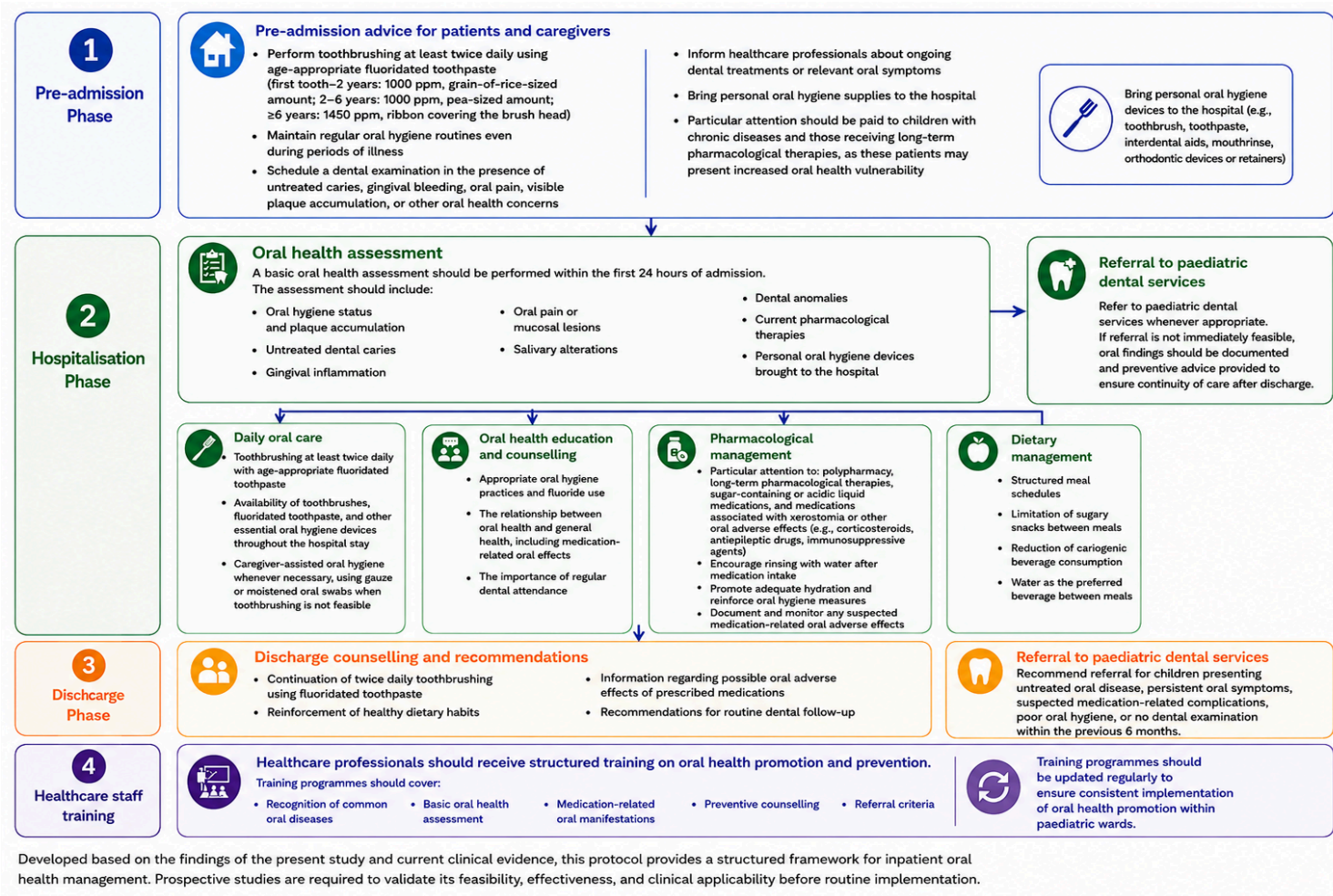


Figure 1

Flowchart of the proposed oral health management protocol for children admitted to non-surgical paediatric wards.

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