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ORIGINAL ARTICLE

Knowledge, opinions and practices of French general practitioners in the assessment of caries risk: results of a national survey

Sophie Doméjean[1] · **Stéphanie Léger**[2] · **Antoine Simon**[1] · **Nadège Boucharel**[1] · **Christopher Holmgren**[3]

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Abstract
Objectives The objective of this study was to describe the knowledge, opinions and practices of French general dental practitioners with respect to caries risk assessment (CRA) through the use of a national questionnaire survey.
Materials and methods A postal questionnaire survey was applied to a simple random sample of dentists (n = 2000) in France. Descriptive and logistic regression analyses were performed.
Results The response rate was 34.7 %. Of the respondents, 38.4 % reported that CRA was not part of their routine practice. Among those who claimed to use CRA only 4.5 % did so using a specific evaluation form. Responses showed that there is great variation among respondents with respect to the importance given to different factors to be considered for the development of a treatment plan in adults. Moreover, 32.3 % of respondents reported no regular scheduling of preventive care based on the caries risk of their patients. Nearly 12 % of respondents admitted they did not know exactly what minimal intervention in caries management involved. The results also showed that socio-demographic characteristics of the practitioner influence the use of CRA and other practice patterns.
Conclusions CRA has not widely entered clinical practice in France.

Clinical relevance: This study, the first of its nature in France, shows the need to develop the use of CRA in daily dental practice in France.

Keywords Caries risk assessment · Minimal intervention dentistry · Questionnaire survey · Dentists · Practice patterns · France

The concept of minimal intervention in dentistry encompasses all preventive and therapeutic measures used to prevent the onset and progression of diseases affecting both soft and hard tissues. Most often, however, the term minimal intervention (MI) is applied to the prevention and management of dental caries [1, 2]. Minimal intervention not only concerns the symptoms of a disease but also the causes [1, 3, 4]. In cariology, its scope is broad: it includes the detection of the earliest possible lesions, the identification and management of risk factors (caries risk assessment - CRA) and the implementation of targeted prevention strategies, including patient education and monitoring. When the effects of the disease are present (caries lesions), other therapeutic strategies are required through the preferential use of less invasive solutions: remineralisation, therapeutic sealants, resin infiltration or, in cases of cavitated carious lesion, restorative care that aims to retain the maximum amount of sound tooth tissue [5].

CRA and the determination of individual risk factors allow the establishment of an individualized treatment plan for each patient to prevent the onset or progression of the disease. Preventive strategies and targeted therapeutic management can then be established with the objective of optimizing

✉ Sophie Doméjean
sophie.domejean@udamail.fr

[1] CHU Clermont-Ferrand, Service d'Odontologie, Hôtel-Dieu, F-63001 Clermont-Ferrand; Univ Clermont1, UFR d'Odontologie; Centre de Recherche en Odontologie Clinique EA 4847, F-63000 Clermont-Ferrand, France

[2] Département de Mathématiques, Univ Blaise Pascal, F-63177 Aubière, France

[3] Aide Odontologique Internationale, Montrouge, France

outcomes. Many caries risk assessment schemes have been developed including the Caries Management By Risk Assessment (CAMBRA) system [6, 7], the Cariogram [7], the system developed by the GC Minimal Intervention Advisory Board [8], the Caries Risk Pyramid [9], the Caries-Risk Assessment Tool (CAT) of the American Academy of Paediatric Dentistry [10], and the Dundee Caries Risk Assessment Model (DCRAM) [11]. In general, these schemes assess pathological factors responsible for the demineralization of dental hard tissue with protective factors involved in the remineralisation of dental hard tissues [4, 12] while also taking into account risk predictors (presence of active and/or arrested caries lesions, presence of numerous restorations in the mouth). Although Tellez et al. [13] have questioned the efficacy and usefulness of CRA systems; an identification of an individual patient's risk factors can guide practitioners in their preventive recommendations and management choices [14, 15]. Fontana et al. consider that even if critics of CRA argue that it is difficult to identify with certainty patients at risk and that the evidence of the effectiveness of preventive measures for individuals at high risk is not always very strong, CRA still has the potential to enhance patient care by allowing the practitioner and the patient to understand the specific reasons for the caries activity and to tailor the treatment plan and recall interval accordingly [14]. In this respect, in France, in 2005, the Haute Autorité de Santé (HAS - High Authority for Health) has made recommendations that emphasize the importance of CRA in developing the overall patient treatment plan and the need for preventive sealing [16]. Although ten years have passed since the publication of these recommendations no data was available on the integration of CRA in general clinical practice in France.

The objective of this study was to describe knowledge, opinions and practices of French general dental practitioners (GPs) with respect to CRA through the use of a national questionnaire survey.

Materials and methods

A questionnaire survey was conducted in early 2015 after obtaining approval from the representative of the "Commission on Information Technology and Liberties" (CNIL) of the University Hospital of Clermont-Ferrand (registration number 0104) and following registration of the study with the Department of Clinical Research and Innovation (DRCI), to comply with French regulations.

Target population and study population

The target population consisted all GPs in active practice in France (about 40,000 persons). The sample size (n = 2000) was determined by taking into account an expected response rate of approximately 40 %, a precision of 5 % in the estimation of the proportion of GPs who undertake CRA in everyday practice (approximately 40 %) and an ability to detect a difference of at least 10 % between sub-groups ($\alpha = 0.05$, $ß = 0.10$). A random sample of 2000 GPs was electronically selected from an authorized list of registered French GPs (Annuaire Dentaire).

Survey

A questionnaire tool was used for data collection; it was developed based on a questionnaire used by Riley et al. [17]. It consisted of five parts:

- Demographic characteristics of the respondents (gender, year of graduation, etc.)
- Questions relating to the participation in continuing education (CE) on cariology over the previous five years both in terms of training courses or the reading of articles,
- Questions relating to the GPs' behaviour concerning the use of CRA, the establishment of treatment plans based on CRA and the possibility of delegation of tasks to other dental personnel, and,
- Questions concerning the understanding and perception of the term "MI in caries management".

Administration of the questionnaire

The questionnaire was sent by post (January 2015) to the randomly selected GPs (n = 2000) with a letter describing the study and a reply paid envelope. Since the questionnaire replies were anonymous, a reminder card was sent by mail 15 days later to all selected GPs in order to optimize the response rate.

Capture and analysis of data

The data were entered into an Excel spread sheet and then analysed with SPSS (IBM SPSS Statistics Version 19).

A $\chi 2$ test was performed to assess the association between the use of CRA, caries management strategies and socio-demographic characteristics of the respondents namely: gender (male versus female), professional experience (<20 years versus ≥ 20 after graduation), age (≥ 50 year old versus < 50 years), type of practice (private practice versus salaried), participation in CE courses and having read articles relating to MI in cariology/restorative dentistry (no versus yes). Regarding the questions related to the CRA determination, the different factors were considered as 'no versus yes'. Regarding the question about the importance of different

factors for the development of a treatment plan for adult patients, statistical analysis was performed with the following subgroups: 'not or only marginally important' (grade 1) versus 'somewhat important' (grade 2) versus 'very to extremely important' (grade 3).

Univariate and multivariate (stepwise) logistic regressions were performed and odds ratios (OR), with confidence interval at 95 % (95 % CI) calculated to indicate the associations between the use of CRA, factors to be taken into account for CRA (important and less important factors) and socio-demographic characteristics of the respondents.

The level of significance was set at 0.05.

Results

Among the 693 respondents, 100 were excluded for the following reasons: they were aged 66 years or more, they had ceased practice, they had moved or had become specialists since their inscription on the list of registered French GPs (Annuaire Dentaire). This resulted in an overall response rate of 34.7 % (n = 593). Table 1 shows the socio-demographic characteristics of respondents compared to that of the general population of French GPs [26].

Utilisation of CRA in general practice

Of the respondents, 38.4 % reported that CRA was not part of their routine practice. Among the 357 who claimed to use CRA only 4.5 % did so using a specific evaluation form.

Table 2 presents the results of the univariate and multivariate logistic regression performed to analyse the associations between the use of CRA and demographic characteristics. The results showed that socio-demographic characteristics of the practitioner influence the use of CRA. CRA was used more by GPs who had recently participated in a CE course (p = 0.0002; OR = 0.51; 95 % CI: 0.36–0.73), GPs who read scientific articles on the topic (p = 0.018; OR = 0.61; 95 % CI: 0.40–0.92) and females (p = 0.023; OR = 0.67; 95 % CI: 0.48–0.95).

Table 3 provides a summary of the reasons why some GPs do not undertake CRA. Lack of time appears to be the most important factor identified (67.2 %). Furthermore 72.7 % of

Table 1 Demographic comparison of respondents and of the national population of dentists

Demographic characteristics	Respondents n = 593	General population of dentists in Metropolitan France• n = 40,000
Gender	Male: 323 (56.3 %)	Male: 60 %
	Female: 251 (43.7 %)	Female: 40 %
	(n = 574)***	
Age (years)	Mean* ± SD: 47 ± 11	Mean**: 48
	Minimum: 26	Minimum: no data available
	Maximum: 65	Maximum: no data available
	(n = 565)***	
Clinical experience in 2015	Mean ± SD: 21 ± 12	No data available
	Minimum: 1	
	Maximum: 43	
	(n = 509)***	
Private practice	Yes: 550 (95 %)	Yes: 98.2 %
	(n = 579)***	
Continuing education	Yes: 215 (37.1 %)	No data available
	No: 365 (62.9 %)	
	(n = 580)***	
Reading of scientific articles	Yes: 464 (80.3 %)	No data available
	No: 114 (19.7 %)	
	(n = 578)***	

SD: standard deviation

*: mean at the study time: in 2015

**: mean in 2013

***: all participants did not answer to all questions

•: Observatoire National de la Démographie des Professions de Santé - Etat des lieux de la démographie des chirurgiens-dentistes – 2013 (22)

Table 2 Results of the logistic regression assessing the associations between the use of CRA in everyday practice and the demographic characteristics of the respondents (n = 500)**

	Demographic characteristics	*P*-value	OR	95 % CI
Univariate LR	Continuing education *	0.0002 *	0.51	0.36–0.73
	Articles *	0.018 *	0.61	0.40–0.92
	Gender *	0.023 *	1.49	1.06–2.10
	Age	0.159	1.28	0.91–1.80
	Clinical Experience	0.420	1.16	0.81–1.65
	Private practice	0.460	0.75	0.36–1.60
Multivariate LR (stepwise)	Gender *	0.022 *	0.65	0.45–0.94
	Continuing education *	0.002 *	0.55	0.37–0.80

LR: logistic regression; OR: Odd ratio; 95 % CI: with confidence interval at 95 %

*: statistically significant difference

**: all participants did not answer to all questions

those who answered that they did not undertake CRA for this reason would welcome the delegation of this task to other dental personnel. Of these, 64.7 % would be prepared to delegate the task to an oral health auxiliary, hygienist or dental assistant, if regulations allowed it, or to a colleague (7.8 %), while 15.6 % would not wish to delegate, and 11.7 % remained undecided.

Table 4 summarizes the hierarchy of factors considered by the respondents in a CRA for adult patients. Overall, the three factors cited as the most important were: oral hygiene (83.4 %), diet (50.3 %) and the patient's motivation (45.8 %). Conversely, the three factors cited as the least important were reimbursement for CRA (74 %), followed by the socioeconomic status and a subjective assessment of the patient, both at 37.7 %. Once again a relationship was found between the GPs' demographic characteristics and the factors to be considered in a CRA. GPs that had been graduated for less than 20 years were less likely to cite reimbursement as a important factor (p = 0.003). More experienced GPs (20 years or more after graduation) (p = 0.001) and those who have recently participated in CE courses (p = 0.024) were less likely to consider a subjective assessment of the patient to be of minor importance in CRA.

Table 5 presents the results of the uni- and multi-variate analyses performed to indicate the associations between the use of CRA and factors considered as being important in a CRA for adults and between the three most cited factors considered as being important in a CRA and respondent demographic characteristics. Patient age was the only item identified from the stepwise logistic regression with a p-value at 0.036 and an OR at 0.44 (95 % CI: 0.20–0.95) showing that GPs who use CRA in everyday practice are less likely (0.44 times) to not cite the age of the patient as an important factor to be taken into account in the CRA. The stepwise analysis showed that respondents who have not read any articles relating to MI in cariology/restorative dentistry dentistry recently were more likely to state that oral hygiene is an important factor in a CRA (p-value: 0.017; OR =2.7 (95 % CI: 1.20–6.08)).

Table 3 Reasons why GPs do not undertake CRA (n = 204)•

	Citation frequency	Significantly related respondent characteristics
Lack of time	67.2 %	Article reading (p = 0.018)
Problem of billing or reimbursement	57.8 %	Male (p = 0.032)
Insufficient knowledge	29.4 %	-
I was not taught CRA during my undergraduate education	18.1 %	-
I was not taught CRA during my postgraduate education/CE	20.1 %	Article reading (p = 0.026)
I do not find it useful	11.8 %	Lack of CE (p = 0.043)

•: among the 223 GPs who do not use CRA in routine practice, 19 did not answer the question

*: statistically significant difference

GPs: general practitioners; CRA: caries risk assessment; CE: continuing education

Table 4 Hierarchy of factors to be considered in a CRA for adults proposed by the respondents (n = 555)•

Factor	Factor of importance %	Less important factor %
Current oral hygiene	83.4	1.8
Current diet	50.3	4.7
Patient's motivation	45.8	2.2
Dentist's subjective assessment	1.8	37.7
Socioeconomic status	5.2	37.7
Reimbursement	1.4	74.0
Presence of active carious lesion	24	2.9
Regularity of patient visits	21.8	5.9
Comprehension of the causes of caries	16	7.8
Decreased saliva function	14.8	5.7
Presence of several large restorations	9.2	9.2
Recent carious lesion*	8.3	7.2
Age	5.1	28.9
Current use of fluoride toothpaste	2.9	13.5
Presence of dental appliances	2.3	18.6
Gingival recession or exposed roots	1.8	21.3

•: All respondents did not answer the question

*: during the last 3 years

CRA: caries risk assessment

Table 6 presents the results of the uni- and multi-variate analyses performed to indicate the associations between the use of CRA and factors considered as being less important in a CRA for adults and the three most cited factors considered as being less important in a CRA (namely reimbursement, socio-economic status and subjective assessment) and respondent characteristics. Patient comprehension of the causes of caries was the only item to be identified from the stepwise logistic regression with a p-value at 0.03 and a OR at 0.49 (95 % CI: 0.25–0.93). None of the respondent demographic characteristic was significantly related to the citation of socioeconomic status as being an important factor in a CRA for adults while reimbursement and subjective assessment respectively were significantly related to clinical experience (p-value: 0.003; OR = 1.88; 95 % CI: 1.25–2.95) and the respondent age (p-value <0.0001; OR = 0.45; 95 % CI: 1.53–3.24).

Treatment planning

Table 7 presents a summary of responses on the importance given to different factors for the development of a treatment plan in adults. It shows that there is great variation among respondents; for example, 45.6 % of respondents believe that the patient's age is important to consider in developing a treatment plan while for other GPs this factor is either "somewhat important" (36 %) or " not or only marginally important " (15.4 %).

The socio-demographic characteristics of respondents appear to influence the emphasis on certain risk factors when determining treatment plans. Indeed, male respondents are more likely than women to designate patient age, the presence of extensive restorations, or the presence of gingival recession or root exposure as being important factors to consider for the development of a treatment plan ($p < 0.001$, $p = 0.032$ and $p < 0.001$ respectively).

Thirty-one percent of participants reported that treatment plans were not formulated according to an assessment of an individual patient's caries risk. The results also show that 32.3 % of respondents reported no regular scheduling of preventive care based on the caries risk of their patients.

Respondents most favourable to the establishment of a treatment plan based on a CRA were women ($p < 0.001$), GPs who had recently participated in CE courses ($p = 0.001$) and those who read scientific articles ($p = 0.02$). The planning of preventive care based on CRA was more common among women ($p = 0.001$), GPs with less than 20 years of experience ($p = 0.001$), those who had recently participated in CE courses ($p = 0.026$) and those in private practice ($p = 0.035$).

Table 8 presents a hierarchy of preventive treatment regularly used by the respondents for their patients. Fissure sealing (86.8 %), fluoride toothpaste >1500 ppm F (64.4 %) were the most commonly used methods used while fluoride varnish, fluoride toothpaste <1500 ppm F, or fluoride mouthwash were used by about a third of respondents. Calcium phosphate based agents were used by only 6.9 % of the GPs.

GPs with less than 20 years of experience generally use fluoride varnish ($p < 0.001$) and prescribe fluoride mouthwash more often ($p = 0.003$) than their more experienced colleagues.

Table 5 Results of the uni- and multi-variate logistic regressions performed to indicate the associations between the use of CRA and factors considered as being important in a CRA for adults and between the three mostly cited factors considered as being important in a CRA for adults and respondent demographic characteristics (n = 500)

LR related to the use of CRA and factors considered as being important in a CRA for adults				
	Factors considered as being important	*P*-value	OR	95 % CI
Univariate LR	Age *	0.036 *	0.44	0.20–0.95
	Diet *	0.047 *	1.42	1.01–2.00
	Hygiene	0.252	0.76	0.47–1.22
	Subjective assessment	0.431	0.61	0.17–2.11
	Exposed roots/recessions	0.431	0.61	0.17–2.11
	Socioeconomic status	0.432	0.74	0.35–1.57
	Decreased saliva function	0.448	1.21	0.74–1.98
	Large restorations	0.481	1.25	0.68–2.29
	Reimbursement	0.482	0.61	0.15–2.45
	Appliances	0.537	0.71	0.23–2.13
	Regularity of visits	0.544	1.14	0.75–1.73
	Patient's motivation	0.564	1.11	0.78–1.56
	Comprehension of the causes	0.572	1.15	0.71–1.85
	Active lesion	0.596	0.90	0.60–1.34
	Recent carious lesions	0.620	0.86	0.46–1.58
	Fluoride toothpaste	0.973	1.02	0.37–2.84
Multivariate LR (stepwise)	Age	0.036	0.44	0.20–0.95
LR related to demographic characteristic and the 3 mostly cited factors considered as being important in a CRA for adults				
	Demographic characteristics	*P*-value	OR	95 % CI
Hygiene				
Univariate LR	Articles *	0.006 *	2.88	1.35–6.17
	Continuing education	0.123	1.43	0.91–2.25
	Private practice	0.391	1.71	0.50–5.77
	Age	0.764	0.93	0.59 –-1.47
	Gender	0.899	0.97	0.62–1.52
	Clinical experience	0.910	1.03	0.63–1.68
Multivariate LR (stepwise)	Articles *	0.017 *	2.70	1.20–6.08
Current Diet				
	Articles	0.275	0.790	0.52–1.21
	Gender	0.503	0.89	0.64–1.25
	Age	0.526	1.12	0.8–1.57
	Continuing education	0.531	0.896	0.64–1.26
	Clinical experience	0.815	1.043	0.73–1.49
	Private practice	0.953	0.977	0.46–2.09
Multivariate LR (stepwise)	-	-	-	-
Patient's motivation				
Univariate LR	Age *	0.024 *	1.48	1.05–2.08
	Articles	0.057	0.66	0.43–1.01
	Gender	0.118	1.31	0.93–1.84
	Clinical experience	0.368	0.89	0.59–1.21
	Private practice	0.636	1.20	0.56–2.57
	Continuing education	0.681	1.08	0.76–1.52
Multivariate LR (stepwise)	-	-	-	-

LR: logistic regression

*: statistically significant difference

Overall, GPs who have read articles on cariology or who have attended CE courses are more likely to use fluoride varnish, fluoride gel and fissure sealing (p 0.001 to 0.047).

Understanding/perception of the term MI in caries management

Table 9 summarizes the responses relating to the question concerning what respondents understood by the term "MI in caries management". Respondents overwhelmingly associated MI with minimally invasive dentistry (83.2 %), while 69.9 % associated MI with a method of care based on prevention. Nearly 12 % of respondents admitted they did not know exactly what MI in caries management involved.

Discussion

Although a study of this type does present certain limitations; even so the findings still help to discern the knowledge, opinions and behaviour of French GPs with respect to CRA in routine general practice.

Even though a reminder card was sent 15 days after sending the questionnaire, the response rate of 34.7 % might be considered to be rather low in that it compares poorly to the

Table 6 Results of the uni- and multi-variate logistic regressions performed to indicate the associations between the use of CRA and factors considered as being less important in a CRA for adults (n = 512) and between and the three mostly cited factors considered as being less important in a CRA for adults and respondent demographic characteristics (n = 444)

LR related to the use of CRA and factors considered as being less important in a CRA for adults				
	Factors considered as being less important	*P*-value	OR	95 % CI
Univariate LR	Comprehension of the causes of caries *	0.030 *	0.49	0.25–0.93
	Age	0.065	1.46	0.98–2.18
	Decreased saliva flow	0.104	2.06	0.86–4.91
	Fluoride toothpaste	0.159	0.69	0.42–1.16
	Subjective assessment	0.168	0.77	0.54–1.12
	Appliance	0.182	1.38	0.86–2.21
	Large restorations	0.231	0.69	0.38–1.27
	Diet	0.247	0.62	0.27–1.40
	Patient's motivation	0.283	0.52	0.16–1.72
	Hygiene	0.303	0.50	0.13–1.88
	Frequency of dental visit	0.356	0.71	0.34–1.48
	Active lesions	0.521	0.71	0.26–2.0
	Exposed roots or recessions	0.799	1.06	0.68–1.64
	Recent carious lesions	0.809	0.92	0.47–1.82
	Socioeconomic status	0.905	1.02	0.71–1.48
	Reimbursement	0.907	1.03	0.68–1.54
Multivariate LR (stepwise)	Comprehension of the causes of caries *	0.030*	0.49	0.25–0.93
LR related to demographic characteristic and the 3 mostly cited factors considered as being less important in a CRA for adults				
	Demographic characteristics	*P*-value	OR	95 % CI
Reimbursement				
Univariate LR	Experience *	0.003 *	1.92	1.25–2.95
	Age *	0.004 *	0.56	0.37–0.83
	Gender	0.320	0.81	0.54–1.22
	Continuing education	0.519	1.14	0.76–1.72
	Private practice	0.564	0.78	0.33–1.83
	Articles	0.671	1.12	0.67–1.88
Multivariate LR (stepwise)	Experience *	0.003 *	1.88	1.22–2.89
Socioeconomic status				
Univariate LR	Age *	0.028 *	1.51	1.04–2.17
	Clinical experience	0.067	0.70	0.48–1.03
	Gender	0.146	1.31	0.91–1.89
	Continuing education	0.172	0.77	0.53–1.12
	Articles	0.699	0.91	0.57–1.45
	Private practice	0.919	1.04	0.46–2.35
Multivariate LR (stepwise)	-	-	-	-
Subjective assessment				
Univariate LR	Age *	<0.0001 *	0.45	0.31–0.66
	Clinical experience *	0.0007 *	1.94	1.32–2.85
	Continuing education *	0.0219 *	1.56	1.07–2.28
	Gender	0.3831	0.85	0.59–1.22
	Articles	0.5340	0.86	0.54–1.38
	Private practice	0.7533	0.88	0.38–2.01
Multivariate LR (stepwise)	Age *	<0.0001 *	0.451	0.30–0.67

LR: logistic regression

*: statistically significant difference

58 % response rate achieved for a similar questionnaire used for a network of US and Scandinavian dental practitioners and the 67 % response rate for Japanese dentists [17, 18]. It does however remain acceptable in the French context since recent questionnaire surveys conducted in medicine and dentistry in France have shown response rates ranging from a low 6 % to 57 % [19–21]: in general, the French medical and dental professions appear to be hesitant to provide information on their clinical practice. Moreover, it could be hypothesised that the higher response rates recorded in the US, Scandinavian and Japanese studies might be related to the fact that the participants were part of a network of practitioners who had volunteered to participate in health care research, while the present questionnaire survey was administrated to a sample of French GPs randomized at a national level.

While it would have been useful to contact non-respondents to follow up on the questionnaire, this was not possible since the questionnaires were, by obligation, anonymous in order to comply with French regulations. Moreover, for this reason, no analysis was possible to study whether respondents were representative of the study population. Recent data (2013) of the National Observatory of the Demography of Health Professions presented in Table 1 [22] does show however that there wasn't a major imbalance

Table 7 Importance of different factors to be considered for the development of a treatment plan in adults

Factor	Not or only marginally important (grade 1)	Somewhat important (grade 2)	Very to extremely important (grade 3)	Significantly related respondent characteristics
Age (n = 578)*	15.4 %	36 %	45.6 %	Male: grades 1 and 2 ($p < 0.001$)
Socioeconomic status (n = 575)*	31.6 %	43.1 %	25.3 %	-
Current oral hygiene (n = 578)*	0.5 %	4.8 %	94.7 %	-
Presence of active carious lesion (n = 577)*	4.5 %	16.5 %	79 %	-
Recent carious lesions** (n = 578)*	10.4 %	31.7 %	57.9 %	-
Presence of several large restorations (n = 581)*	8.4 %	32.2 %	59.4 %	Male: grades 1 and 2 ($p = 0.032$) No article reading: grades 1 and 2 ($p = 0.007$)
Presence of dental appliances (n = 580)*	10.5 %	39.1 %	50.4 %	No CE: grades 1 and 2 ($p = 0.024$)
Gingival recession or exposed roots (n = 581)*	18.7 %	35.3 %	46 %	Male: grade 1 ($p < 0.0001$)
Current use of fluoride toothpaste (n = 576)*	30 %	33.7 %	36.3 %	No article reading: grades 1 and 2 ($p = 0.004$)
Current diet (n = 580)*	18.6 %	25.2 %	56.2 %	No CE: grades 1 and 2 ($p = 0.014$) No article reading: grade 3 ($p = 0.001$)
Dentist's subjective assessment (n = 572)*	19 %	40.6 %	40.4 %	Experience <20: grade 1 ($p = 0.005$)
Decreased salivary function (n = 581)*	10.8 %	20.1 %	68.1 %	Article reading: grades 2 and 3 ($p = 0.005$)
Patient comprehension of the causes of caries (n = 580)*	7.2 %	17.6 %	75.2 %	-
Regularity of patient visits (n = 581)*	3.3 %	15.5 %	80.2 %	-
Patient motivation (n = 582)*	0.4 %	7.2 %	92.4 %	-
Reimbursement (n = 578)*	38.9 %	41.2 %	19.9 %	Experience <20: grade 3 ($p = 0.025$)

*: all participants did not answer the question for all variables

CE: continuing education

between respondents and the GP population even though the prevalence of women was marginally overrepresented; 43.7 % in this present study against 40 % in the GP population.

The questionnaire used in the present survey was designed specifically for the study but was in part based on one developed by Riley et al. [17]. In common with the US, Scandinavian and Japanese questionnaire studies on CRA, specific validation of the questionnaire was not undertaken [17, 18] since the objective of this study was to describe the knowledge, opinions and practices of practitioners concerning CRA and its impact of treatment planning. This differs from questionnaires where the aim is to diagnose a disease, to screen patients according to a specific medical condition or to assess quality of life where validation is necessary. Construct validity was, however, evaluated to some extent by pilot-testing the questionnaire on students and faculty members (n = 110) at the dental school of Clermont-Ferrand. Minor problems in the understanding and interpretation of certain questions were discussed among the investigators and slight modifications to the questionnaire were made. Validation in terms of test-retest reliability of the questionnaire was not evaluated since it was considered that once the questionnaire has been administered, respondents might seek further information about certain topics covered in the questionnaire, which, in turn, might subsequently change their opinions and practises. Linguistic validity was not required since the questionnaire was developed in French.

In this survey, 38.4 % of respondents claimed not to use CRA in their clinical practice. This figure may seem high considering the importance of managing causative factors in the field of caries management. The result is, however, similar to the 31 % reported by Riley et al. for US and Scandinavian practitioners [17] but is very much lower than the 74 % of Japanese dentists who claim not to use CRA [18].

Table 8 Hierarchy of preventive techniques regularly used by the respondents (n = 567) •

	Citation frequency	Significantly related respondent characteristics
Sealant	86.8 %	Articles (p = 0.007)
Fluoride toothpaste >1500 ppm	64.4 %	-
Fluoride varnish	32.6 %	Experience <20 (p < 0.001) CE (p = 0.047) Articles (p = 0.001)
Fluoride toothpaste <1500 ppm	32.5 %	-
Fluoride mouthrinse	31.9 %	Experience <20 (p = 0.028)
Fluoride gel	18.2 %	CE (p = 0.005)
Products containing calcium and phosphate	6.9 %	-

Several options may be chosen

CE: continuing education

•: among the 593 respondents, 26 did not answer the question

Unfortunately, questionnaire surveys have a tendency to provide a more positive picture than that which really occurs in dental practice on the assumption that only practitioners who are most motivated in the subject area tend to respond to such questionnaire surveys. It could be hypothesised that the percentage of practitioners actually realizing CRA in daily practice is probably much lower. This is detrimental in the context that CRA is essential in order to practice minimal intervention in a reasoned manner [5]; it is not only useful in the determination of a predictive risk level in the risk of new lesions in the future but especially the determination of each pathological factor involved in each clinical case to attempt to correct or compensate for it by strengthened preventive measures. Certainly, the various proposed CRA systems are not all subject to validation [13], however, it seems more appropriate to perform CRA based on the best available evidence that doing nothing citing a lack of compelling evidence [14]. Among the French GPs who claim that they assess the caries risk of their patient, less than 5 % use a specific form. This compares unfavourably to the 17 % reported by Riley et al. [17] for adults patients among a network of American and Scandinavian GPs who use a special form when assessing caries risk but is below the 31 % of those Japanese GPs who undertake CRA and who use a form [18].

The use of CRA in everyday practice seems to be influenced by certain demographic characteristics (Tables 2, 5 and 6); a finding which is in common with decision-making related in particular to restorative decisions among French GPs [21]. The results for the hierarchy of factors that the respondents considered to be important when assessing the CRA for adult patients help to give some insight on the matter (Table 4), but it cannot be inferred with certainty that it reflects the reality of the factors actually taken into consideration in the clinic. The multivariate logistic regression assessing the association between the three factors that were cited as being the most important when assessing the CRA for adult patients and respondent characteristics (Table 5) showed that the only association was between the lack of reading of scientific articles by the respondents and patient oral hygiene. In retrospect, an open-ended question about the factors to be considered in clinical practice might have been more pertinent. In the present study, the most cited factors to consider for CRA were the

Table 9 What do respondents understood by the term "MI in caries management"? (n = 571) •

MI in caries management is….	Citation frequency * %
A treatment concept based on minimally invasive dentistry	83.2 %
A treatment concept based on prevention	69.9 %
A treatment concept that can be implemented into private practice	53.4 %
A treatment concept based on the understanding of the risk factors	48.2 %
A treatment concept based on the use of magnification	30.1 %
I do not know exactly what is the minimal intervention in cariology	11.9 %
A treatment concept that cannot be implemented into private practice	6.8 %
A treatment concept that is part of the public health domain	1.6 %
A treatment concept restricted for use in paediatric dentistry	1.4 %

*: some respondents choose several options

•: some respondents did not answer the question

current oral hygiene, the current diet habits and the patient motivation. While for Japanese GPs, Kakudate et al. [18] similarly reported that current oral hygiene was the most important factor to consider, followed by willingness to follow up and active carious lesion, surprisingly, the use of fluorides was reported to be the least important factor to consider. These results show the general lack of knowledge of GPs concerning CRA. This is also evident in terms of the understanding and the perception of the term "Minimal Intervention" in caries management.

It is disturbing that only 37.1 % of respondents reported to have undergone CE in the field of cariology over the past five years. This figure is low considering that a large component of general practice involves the management of caries and the provision of restorative care. Moreover, this figure must be seen in the context that in 2012, 45.6 % of reimbursements for dental treatment in France were for restorative care, initial and recurrent caries lesions included [22]. Nevertheless the present results show that CE, both training courses and/or scientific publications, are needed to update GPs knowledge and practice in CRA and MI. This might then have an influence the practice of CRA since the study has shown an association between CE and the use of CRA, the development of treatment plans and preventive care implemented. It can be hypothesised that the behaviours of French GPs toward CE might be linked to the lack of recognition of actual cariology management concepts in the national health coverage system (see above).

Among the GPs who responded that they do not undertake a CRA, almost 70 % mentioned lack of time as a barrier to its integration in daily practice. Among them, 64.7 % would be willing to delegate this task to an oral health ancillary such as a hygienist or dental assistant if regulations allow. In general, creating a patient-centred team with the possibility of task delegation between the dentist, an assistant or hygienist makes the changing practices easier [23, 24]. In France, the dental profession generally seems reluctant to integrate hygienists notwithstanding the benefits to their practice. The recognition of the hygienist may allow patients to have the opportunity to have access to CRA, as well as care or diagnostic techniques that are not necessarily implemented by GPs. In addition, the integration of hygienist in dental practice could be an incentive for GPs to develop and integrate their management of caries based on risk factors and more holistic approach in their daily practice. A form of hypocrisy exists insofar as a document of the General Inspectorate of Social Affairs (Inspection Générale des Affaires Sociales or IGAS) [25] reports the results of a recent survey by the National Confederation of Dental Trade Unions (Confédération Nationale des Syndicats Dentaires or CNSD), which has identified that many dentists illegally delegate tasks to their dental assistants such as the taking of radiographs, bleaching, impressions for study casts or other work of this type and periodontal maintenance in significant proportions (respectively 17 %, 11 %, 4 % and 3 %).

The absence of CRA in the Common Classification of Medical Acts (CCAM), used as a basis for reimbursement, applicable since the beginning of June 2014, is regrettable and illustrates the lack of appreciation of the importance of cariology in the modern management of the disease by government decision makers and their advisors in France. Even though there is no reimbursement provided for a periodontal assessment, it still has a classification code in the CCAM. Conversely, CRA which is cited by the HAS [16] in the national recommendations as necessary for the management of patients and for the planning of preventive treatment remains absent in the classification. Regrettably, the lack of recognition and reimbursement does not only concern CRA but MI strategies in general (absence of codes for preventive and non-invasive therapies except for preventive dental sealants before the age of 14 years) does little to encourage practitioners to change their existing invasive professional practises [21].

Conclusion

This study, which is the first of its nature in France, shows the need to develop the use of CRA in daily dental practice in France. To meet this objective, work on several levels appears to be necessary. The first is to equip future dentists with the competencies required to be able to undertake CRA and MI when they qualify. In this context, Pitts et al., [26] concluded that for the European Core Curriculum in Cariology, that dentists on graduation "must be sufficiently competent at CRA, diagnosis and synthesis to ensure the appropriate, continuing prevention, control and management of dental caries and to enable patient-centred and shared clinical decision-making." For those dentists who are already in practice there is need to update their existing competences in matters concerning CRA and MI through the organization of CE courses and articles in professional journals. Lastly, and to encourage the use of MI in general practice, there should be the creation of a specific CRA code in the CCAM, combined with recognition of CRA through reimbursement in the same manner as exists for restorative treatment.

Compliance with ethical standards

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Conflict of interest The authors declare that they have no conflict of interest.

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Informed consent Non applicable.

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