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ORIGINAL ARTICLE

Improved oral hygiene and *Candida* species colonization level in geriatric patients

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OBJECTIVES: This work consists in improving oral hygiene (OH) for elderly dependent people in long-term hospital care, in order to decrease the degree of colonization and the associated risk of developing oral candidiasis. As this population frequently suffers from such colonization and because it is difficult to install and practice OH care, a study protocol was designed at the request of geriatricians. The objective of the present study was to set up a programme of OH, applied by the care staff, and to monitor oral colonization of by *Candida* spp.

BASIC RESEARCH DESIGN: We compared the levels of hygiene and *Candida* spp. colonization for a group of 110 long-term patients in geriatric departments at T1, when clinical data were collected and oral mycological samples taken before the OH protocol was applied, and at T2, during the postprotocol phase after 3 months of application, when the clinical data and sample collection were repeated.

RESULTS: During these 3 months 11 patients died. These patients were excluded from the results, which are presented for matched series of the 99 patients still present at T2. Statistical analysis comparing the clinical and biological parameters at T1 and T2 established that there had been an improvement in OH: the 'adequate' level was reached for 72.4% of patients at T2 compared with 41.8% at T1 ($P < 0.001$) and the 'very inadequate' level was observed for 9.2% at T2 compared with 27.9% at T1 ($P < 0.01$). A reduction was observed in the number of patients showing the highest degree of *C. albicans* and *C. glabrata* colonization (>50 colony forming units) from 41.9% at T1 to 24.9% at T2 ($P < 0.05$) and from 56.4% at T1 to 13.0% at T2 ($P < 0.05$) respectively. The number of patients with candidiasis fell significantly from 43.2% at T1 to 10.2% at T2.

CONCLUSIONS: The OH protocol led to an overall decrease in *Candida* spp. colonization, a significant reduction in the number of candidiasis and an improvement in the level of oral and denture hygiene but vigilance is still necessary concerning OH care and the initial training of staff in specific care of the mouth.
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Introduction

The precarious state of health of elderly patients in hospital geriatric care is reported by Chiappelli *et al* (2002) and Guivante-Nabet *et al* (1998). It concerns not only dental and paradontal pathologies (Shay and Ship, 1995; Mersel *et al*, 2000) but also hygiene and colonization by *Candida* spp. for about 70% of patients (Kuc *et al*, 1994; Blair *et al*, 1995; Chiappelli *et al*, 2002; Clay and Nelson, 2002; Imsand *et al*, 2002; Grimoud *et al*, 2003; Isaksson *et al*, 2003). Such colonization falls within the general context of an increase in *Candida* spp. infections during the last 20 years (Fischer-Hoch and Hutwagner, 1995; Nguyen *et al*, 1996; Pfaller *et al*, 1998, 1999; David and Snydman, 2003).

For this vulnerable population, the risks associated with the *Candida* spp. colonization are oral candidiasis, a common opportunistic infection of the oral cavity caused by an overgrowth of *Candida* spp. (Akpan and Morgan, 2002), difficulty in eating, and systemic infections (Loesche *et al*, 1995; Kulak-Ozkan *et al*, 2002; Ohno *et al*, 2003).

As the oral cavity is the principal *Candida* spp. reservoir in the organism, with 60% of subjects colonized asymptomatic in the general population (Epstein, 1996), *Candida* spp. can be isolated from the oral cavity more frequently than pathologic changes are observed (Fotos *et al*, 1992). The studies by Kulak-Ozkan *et al* (2002) and Yonezawa *et al* (2003) stress the interest of

reducing the level of colonization and the number of subjects colonized. The most frequently identified risk factors for the development of oral candidiasis are the wearing of dentures, the degree of *Candida* spp. colonization, a lack of hygiene (Oksala, 1990; Fanello *et al*, 2001; Clay and Nelson, 2002; Kulak-Ozkan *et al*, 2002; Luo and Samaranayake, 2002), tobacco use (Rindum *et al*, 1994), xerostomia (Ettinger, 1996; Bassichis and Marple, 2002), a deterioration in the general state of health (Oksala, 1990; Axell, 1992) and also antibiotic therapy (Akpan and Morgan, 2002).

To alleviate the effects associated with these colonization-favouring factors, Shay and Ship (1995) and Stanfield *et al* (2003) recommend taking preventive or palliative measures, particularly since, as underlined by Chiappelli *et al* (2002) the number of elderly people is gradually increasing. With this in mind, Sumi *et al* (2002) developed a systematic oral care programme for frail dependent persons or institutionalized elderly adults.

The first difficulty to be overcome when attempting to improve oral hygiene (OH) care is the lack of training among care staff (Steele and Walls, 1997; Marshall *et al*, 2002; Nordenram and Ljunggren, 2002). It appears indispensable that staff be made aware of the importance of OH, given the vulnerability of elderly patients (Shenkin and Baum, 2001; Friedlander and Friedlander, 2003).

The connection that has been established between OH and colonization by *Candida* spp. (Blair *et al*, 1995; Kulak-Ozkan *et al*, 2002; Yonezawa *et al*, 2003; Grimoud *et al*, 2003) should lead to improvements in OH practices now that OH protocols can be evaluated through an objective criterion, the evolution of *Candida spp*. colonization (Blair *et al*, 1995; Kulak-Ozkan *et al*, 2002; Yonezawa *et al*, 2002).

With this in mind and at the request of the long-term geriatric care departments of the Toulouse hospitals, we set up a multidisciplinary team.

Our aim was to motivate and train the care staff so that an effective OH protocol could be instituted. The comparison of oral colonization before and after 3 months of application of the OH protocol was used to assess its effectiveness.

Materials and methods

The patients were selected on the basis of the inclusion and exclusion criteria given below and after the informed consent of either the patient or her/his legal representative had been obtained by the departmental geriatrician. The consent was recorded in duplicate, one copy being given to the patient or her/his legal representative.

The inclusion criterion was sufficient opening of the mouth. The exclusion criteria were: patient's opposition to the activities necessary for an oral examination, the taking of oral samples or the application of hygiene care; and antifungal therapy in the 2 months preceding the start of the programme.

The study group was composed of 110 patients hospitalized in seven long-term geriatric care units. Their average age was 85.8 years, 77.3% were women, and 80% had been in hospital for more than a year.

The clinical and biological parameters of each patient included in the study were recorded (Grimoud *et al*, 2003). Data were collected by the doctors and supervisory nursing staff of the unit for the parameters concerning the overall state of health, dependence, and current treatment. The dentist carried out a clinical examination of all the patients, collecting all the variables to define oral status and taking samples for mycological identification.

The most common medical conditions of the study population were: mental illness (87.3%) in which 70% of patients suffered from severe cognitive impairment: vascular dementia and/or degenerative dementia, diabetes (10.0%), presence of bed sores (12.7%), high blood pressure (44.5%) and cancer (9.2%). The most frequently used therapeutic medicines were: psychoactive (52.7%), anti-hypertensive (44.5%), antineoplasic agents (9.2%) and antibiotic (29%) drugs given more than 2 months previously.

For dental hygiene care, 65.2% of the patients were totally dependent on the nursing staff.

The oral data were collected and samples sent to the mycology laboratory at T1, before the start of the OH protocol, and at T2, after 3 months of application.

The clinical indicators of oral status were:

(i) The state of the mucosa:
  - Xerostomia, classified by increasing seriousness: saliva not plentiful, saliva absent, and mucosa covered with mucositis;
  - Candidiasis, defined according to the clinical signs and their localization on the oral mucous membranes as: (i) hyperplastic: white patches that occur on the surface of the tongue, buccal mucosa, hard and soft palate and oropharynx, (ii) atrophic: papillary atrophy of tongue dorsum, (iii) erythematous or denture stomatitis: localized erythema of tissues covered by dentures, (iv) angular cheilitis: erythematous fissuring at one or both corners of the mouth.
  - Gingivitis, characterized by inflamed and bleeding gums;

(ii) The presence of teeth and the existence of caries;

(iii) The 'global' level of dental hygiene. Whether or not the patient had teeth and/or dentures, global hygiene was divided into three levels: adequate – no visible plaque; inadequate – accumulation of plaque at the base of the teeth; very inadequate – large accumulation of plaque and/or presence of tartar.

Oral samples taken from each patient in the morning before breakfast by scraping the oral mucosa with a curette. The sample was transferred to a swab and immediately sent on a transport medium to the mycology laboratory.

For the mycological identification, as previously described (Grimoud *et al*, 2003), the analysis of samples included a direct examination, culture and isolation on CHROMagar (CHROMagar, Paris, France), a filamentation test and identification on Api 20C Aux kit (Bio Mérieux Vitek, Lyon, France). For each strain

identified, the number of colony forming units (cfu) in culture was classified into one of three groups: group 1 > 50 cfu, group 2 between 10 and 50 cfu, group 3 < 10 cfu. The diagnosis of candidiasis was established by taking account of the clinical signs and the number of cfu (Fotos *et al*, 1992; Epstein, 1996). In our study, candida aetiology of the lesions was improbable when the number was < 10 cfu, not very probable when between 10 and 50 cfu and to highly probable when > 50 cfu (Maillié *et al*, 1999). Therefore a positive culture in the absence of other diagnostic signs and symptoms did not necessarily imply candidal mucosal disease (Epstein *et al*, 1980).

There were three stages in the implementation of the OH programme: the seven units were provided with the equipment necessary for putting the OH into practice and treating all the clinical cases defined by the oral parameters of the 110 patients included in the study.

The care team had a storage chest for the equipment. Depending on the clinical case, it contained: toothbrush, toothpaste; brush, denture box and antiseptic tablets for removable dentures, sterile gauze compresses and physiological saline (Physiologica, Gifrer, Decine, France) for the mucous membranes; and moistening gel (Bioxtra, Pharmadent, Levallois Perret, France) as a saliva substitute for cases of xerostomia.

All 203 members of the care staff were trained in the seven geriatric units. Training included two phases:

- A slide show on the specificity of OH in geriatrics was presented to cover some basic principles of anatomy, physiology and microbiology; the main oral pathologies and their risk factors; and the hygiene care appropriate to the various clinical cases. This included hygiene of the teeth, mucous membranes and removable dentures, and the care to be given in cases of xerostomia or candidiasis.
- The correct way of carrying out the OH care for the various clinical cases was demonstrated at the patient's bedside by the dentist responsible for the protocol. The cases treated were: tooth brushing; removal, brushing and antiseptic treatment (Polident PRO; Glaxo Smith Kline, Marly-le-Roi, France) of dentures before replacing them in the mouth; hygiene of mucous membranes using gauze compresses soaked in Physiologica physiological saline; and application of Bioxtra gel as a substitute for saliva in dry mouths.

The OH form made out for each patient showed the prescription for her/his specific oral status. The OH programme was the same for all the patients belonging to given group, i.e. having the same type of mouth. The form was intended for the care staff and mentioned the equipment necessary for the OH treatment and described how to perform it in the morning after breakfast and in the evening after dinner. The prescriptions were: for teeth, a toothbrush and toothpaste; for dentures, a suitable brush, toothpaste and Polident PRO; for the mucous membranes, gauze compresses and Physiologica; and for dry mouths Bioxtra. The number of products prescribed corresponded to the oral status of the patient, e.g. if the patient had some teeth, a partial denture, and xerostomia, the prescription was a toothbrush, toothpaste, Polident PRO and Bioxtra gel. The hygiene care was given two times a day for all patients. The Polident PRO denture treatment was only performed after the evening meal and denture brushing.

The application of the OH protocol was checked twice a week for 3 months by the dentist in charge and the senior staff nurse. The geriatric unit to be checked was selected at random by drawing lots at the time of the visit. The check concerned: the presence of the equipment necessary for each patient examined and the level of OH according to the criteria defined above and described in a previous publication (Grimoud *et al*, 2003). For all the patients examined during the checks, the dentist in charge reported all the assessment parameters on a form.

The statistical analysis was carried out in the Epidemiology Department of the Toulouse University Hospital Centre. Data were input through D.M.90 software and the analysis itself used the EPI-INFO tool. It was based on comparisons of frequency distributions by chi-squared with Mac Nemar and Stuart Maxwel tests and a value of $P < 0.05$ was considered as statistically significant.

Assigning patients to subgroups according to their various oral pathologies gave numbers too small to be used in any significant statistical analysis.

Results

During the 3 months over which the OH protocol was applied, 11 patients died. These patients were excluded from the results, which are presented for matched series of the 99 patients still present at T2, i.e. when the second set of data was collected.

During the programme all OH care was carried out by the staff. Indeed, the level of dependence for the activities of daily living was 76.4% for eating and mobility and 86% for incontinence, and most of the study population suffered from mental illness (87.3%).

Over the 3 months in which the application of the hygiene protocol was supervised (Table 1), 268 oral verifications were carried out and the presence of the

Table 1 Results of oral hygiene checks during the 3 months of application of the protocol for the different categories of mouths

	Hygiene[a]		
Oral hygiene checks n = *268*	*Adequate*	*Inadequate*	*Very inadequate*
Edentulous with no dentures ($n = 64$)	85.9%	11.6%	2.5%
Edentulous with dentures ($n = 54$)	80.4%	10.4%	9.2%
Dentate with no dentures ($n = 113$)	67.3%	18.3%	14.4%
Dentate with dentures ($n = 37$)	54.1%	26.7%	19.2%

[a]The proportion of adequate *vs* inadequate and very inadequate results was significant $P < 0.01$.

Table 2 Principal parameters of oral status before oral hygiene protocol and after 3 months of application

Oral state	*T1 (%)*	*T2 (%)*	P-*value*
Oral mycosis	43.2	10.2	< 0.001
Xerostomia	25.1	15.3	NS
Oral hygiene			
Adequate	41.8	72.4	< 0.001
Inadequate	30.3	18.4	NS
Very inadequate	27.9	9.2	< 0.01
Denture hygiene			
Adequate	31.8	75.0	< 0.001
Inadequate	32.6	14.1	NS
Very inadequate	35.6	10.9	< 0.001

NS, not significant.

Table 3 Number of subjects colonized and colonization level before oral hygiene protocol and after 3 months of application

Candida *spp.*	*Colonization* (n = 99)	*T1 (%)*	*T2 (%)*	P-*value*
C. albicans	Subjects colonized	57.5	44.4	< 0.05
	Number of colonies in culture			
	< 10 cfu	26.8	40.9	< 0.05
	10–50 cfu	30.3	34.2	NS
	> 50 cfu	41.9	24.9	< 0.05
C. glabrata	Subjects colonized	17.8	22.3	NS
	Number of colonies in culture			
	< 10 cfu	16.0	34.8	< 0.05
	10–50 cfu	27.6	52.2	< 0.05
	> 50 cfu	56.4	13.0	< 0.05

OH equipment checked. The equipment was incomplete in 10.3% of cases. OH was found to be 'adequate' for 77.1% of mouths checked in the first month, 69.3% the second month and 74.2% the third month.

During the time when application of the protocol was monitored, for an 'adequate' level of hygiene, a significant difference ($P < 0.01$) was noted depending on the oral status (Table 1). Hygiene was 'adequate' in 86% of patients having neither teeth nor dentures, 80.4% of patients with full dentures, 67.2% of patients with their own teeth, and 54.1% of those having their own teeth with partial removable dentures. This means that hygiene was less good when the care required was more complex, combining tooth brushing and denture care. Patients were sometimes unwilling to cooperate and staff found it difficult to remove dentures and put them back. The overall proportion of oral candidiasis gradually decreased in later checks.

The study population presented: complete absence of teeth in 40.0% of cases, neither teeth nor dentures in 21.8%, and partial or full dentures in 32.7% of cases.

The statistical analysis using a chi-squared test concerned the main oral characteristics noted at T1 and T2 for the 99 patients present. The parameters studied were (Table 2) candidiasis, xerostomia and the level of OH.

The clinical candidiasis diagnoses at T1 concerned a hyperplasic candidiasis localized on the dorsal side of the tongue in over 95% of cases but spread over the whole oral cavity in 5% of cases. Candidiasis affected women more often than men (48.2% *vs* 24.0%) and the difference remained significant after adjustment for age ($P < 0.05$). The development of the candidiasis was not statistically influenced by the type of treatment followed by the patients or the most common medical conditions, bearing in mind that all these old patients present a general deterioration in health. Candidiasis was statistically significantly ($P < 0.001$) associated with a high degree of colonization by *Candida* spp., cfu > 50.

There was no significant link between the wearing of dentures and the presence of candidiasis ($P < 0.054$), so no significant differences could be shown between the subgroups of patients with partial or complete dentures.

The number of candidiasis dropped significantly between T1 and T2 ($P < 0.001$). The decrease in the number of patients with xerostomia, falling from 25.1 to 15.3%, was not significant (Table 2).

The OH involving tooth brushing and mucous membrane care using the compresses led to improvements and the number of patients with the 'adequate' level rose from 41.8% at T1 to 72.4% at T2 ($P < 0.001$), while the 'very inadequate' proportion fell from 27.9% at T1 to 9.2% at T2 ($P < 0.01$). Only the 'inadequate' level of OH showed no significant improvement. The increase in denture hygiene was also significant and the proportion reaching the 'adequate' level rose from 31.8% at T1 to 75.0% at T2 (Table 2). The results concerning the high degree of colonization of the oral cavity by *Candida* spp. showed (i) that the number of *Candida* spp. detected was related to development of candidiasis ($P < 0.05$) and (ii) that colonization decreased after application of the OH protocol for 3 months (Table 3). We present the change in the percentages between T1 and T2 for *C. albicans* and *C. glabrata* only, the other species identified, *C. krusei*, *C. tropicalis* and *Saccharomyces cerevisae*, making up < 3% of the total. At time T2, 76 strains of *Candida* spp. were isolated and the number of patients colonized had dropped from 67.3% at T1 to 62.2% at T2. Species identification suggested that their distribution had changed to the advantage of *C. glabrata*, although the difference was not statistically significant. For the *C. albicans* and *C. glabrata*, the degree of colonization fell significantly and the number of cfu was higher in the group of patients who wore dentures.

Discussion

The oral status of the group of dependent elderly people that we initially established is in agreement with the results obtained by Nordenram and Ljunggren (2002); Guivante-Nabet *et al* (1998); Isaksson *et al* (2003) and Mersel *et al* (2000). As severe colonization by *Candida* spp. (Budtz-Jorgensen, 1990) in patients in long-term geriatric care is encouraged by their inability to carry out OH care without at least partial help from care staff (Friedlander and Friedlander, 2003; Stanfield *et al*, 2003), we set up an OH programme for 110 dependent elderly patients, suffering from mental deterioration in

over 80% of cases. Following the training given to the care staff, this programme led to an improvement in oral care practices from the first month of its implementation. The effectiveness of this type of training has also been noted by Rak and Warren (1990).

With regard to the statistics, we considered differences between T1 and T2 for the same subject. In the absence of a control group, the differences noted between the two times of examination could be related to the effect of the programme or the natural evolution of these parameters. No special care other than the protocol described was applied during this period.

After 3 months of application, we obtained a statistically significant overall improvement in the proportion of 'adequate' OH. For mouths and dentures, the proportion rose between T1 and T2. But if we consider the whole oral cavity, the most satisfactory level of OH was reached when patients had neither teeth nor dentures, or had full dentures, and the least satisfactory level occurred when patients had lost some of their teeth and wore partial removable dentures. Handling these dentures, which have hooks, can prove difficult for the care staff in frail, rather uncooperative patients with poor oral status. *Candida* spp. colonization is therefore greater in subjects possessing dentures in spite of the improvement in OH and agrees with the recommendations given by Kulak-Ozkan *et al* (2002) and Steele and Walls (1997). These authors stated that the cleaning of removable dentures made of acrylic resin should include mechanical cleaning with a brush and chemical disinfection as the resin of the dentures is colonized both on the surface and to a certain depth.

Continuing along these lines, recent work on the problem of the colonization of dentures have looked for other means of action, such as antifungal treatment of the dentures and disinfecting them by microwave (Egusa *et al*, 2000; Banting and Hill, 2001). The most effective seems to be the use of antifungal products. Egusa *et al* (2000) have demonstrated that the attachment of *Candida* spp. to acrylic resin is inhibited by subtherapeutic concentrations of nystatin and amphotericin B. These procedures, different from the ones we used i.e. brushing and immersion in an antiseptic that acted by releasing oxygen, are not for daily use but may be applied exceptionally.

For xerostomia, our protocol provided for specific care combining hygiene and the application of a moistening gel to substitute for saliva, as suggested in the works of Epstein *et al* (1992); Loesche *et al* (1995); Ettinger *et al* (1996) and Ohno *et al* (2003). For this pathology, we did not find any significant difference between T1 and T2 concerning the presence of candidiasis, although studies by Rak and Warren (1990) and Ettinger (1996), suggest that xerostomia increases the risk of developing candidiasis.

No multivariate analysis could be carried out because all the subjects suffering from xerostomia received the treatment; their was no unexposable control group.

Our results do not show any statistically significant increase attributable to the wearing of denture in the number of patients affected by candidiasis. Other studies linking the presence of candidiasis with denture wearing were carried out under conditions markedly different from those of the present work, e.g. level of OH not determined and a majority of smokers among the subjects of Crockett *et al* (1992), a feature that was absent in our population. Laboratory confirmation was absent in Crockett's work: not all the erythematous lesions under the dentures were due to candidiasis.

Concerning the distribution of the species of *Candida* involved, the present study shows a percentage of *C. glabrata*, which now represents 24% of the *Candida* spp. isolated; whereas, in the 1980s, Kuc *et al* (1994) identified 1.4% of *C. glabrata*. The distribution of *Candida* spp. has thus changed in the last 10 years or so. Wingard (1995), links this increase to selection brought about by inappropriate antifungal therapy. Indeed, *C. glabrata* is not sensitive to certain antifungal molecules and the many prescriptions given without prior identification of the species could well underlie the significant increase in *C. glabrata* candidiasis.

As far as colonization by *Candida* spp. is concerned, if we consider the number of subjects colonized, the results were different for *C. albicans* and *C. glabrata*. For *C. albicans* the number was markedly reduced between T1 and T2, and for *C. glabrata* there was a non-significant increase. The percentage of subjects colonized in our study, about 20%, is in agreement with data in the literature (Luo and Samaranayake, 2002). The reduction was statistically significant for *C. albicans* and *C. glabrata*; the percentage of patients suffering from the highest degree of colonization (cfu > 50) dropped significantly at T2 for *C. albicans* and *C. glabrata*. These results are in agreement with those of Yonezawa *et al* (2003).

The slight increase in the number of subjects colonized by *C. glabrata* at the end of the three months of OH protocol application can be put down to the specificities of this species, which has emerged during the last 10 years (Nguyen *et al*, 1996; Luo and Samaranayake, 2002; Grimoud *et al*, 2003). Luo's study (Luo and Samaranayake, 2002) of the adhesive properties of *C. glabrata* indicates that the species has a greater capacity to adhere to acrylic resin surfaces than *C. albicans* ($P < 0.0001$). Although the increase in the number of patients colonized by *C. glabrata* at T2 cannot be definitely attributed to this property, it nevertheless remains a possible hypothesis. Clinically, candidiasis associated with colonization by *C. glabrata* have no characteristics that distinguish them from colonization by *C. albicans*.

For the population studied, the direct benefit associated with a decrease in colonization by *Candida* spp. was a reduction in the risk of developing candidiasis. In the long term, this programme meant that entrance forms were written out and oral monitoring files set up, and that each new arrival had samples taken so that the type and level of colonization could be determined. These measures should improve patient follow-up and help their oral health to be taken in hand.

The improvement in the level of OH care and the decrease in the degree of *Candida* spp. colonization were

obtained thanks to the preliminary study of the terrain. Following on from this study, systematic screening for oral carriers of *Candida* spp. has been set up to detect them as soon as they arrive in the geriatric departments. Only concerted action by therapists, biologists and researchers will allow this problem to be mastered and an improvement to be obtained in the quality of life of elderly people.

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