Abstract

Objectives: Despite strong literature-based evidence highlighting the role of oral care in the prevention of aspiration pneumonia (AP), the relation between the point rating system of bedside oral hygiene exam (point oral exam) and pneumonia-causing bacteria is hardly reported. In this study, point oral exam by the nutrition support team was conducted at each patient’s bedside, and we analyzed the correlation between point oral exam and detection of pneumonia-causing bacteria to examine whether oral hygiene assessment correlates with bacterial pneumonia in hospitalized patients.

Methods: Sixty-one hospitalized patients received clinical examination in various wards of the Kanazawa University Hospital. Point oral exams (0–12 points) were applied to 55 patients who were admitted to the hospital during the period of January 1, 2013 and June 30, 2013. Pneumonia-causing bacteria were detected by cultivating mucus and tissue from sputum and airway mucosa obtained from each patient.

Results: Patients positive for pneumonia-causing bacteria (n = 13) scored significantly lower in point oral exams compared with bacteria-negative patients (5.4 ± 0.7 vs. 3.4 ± 0.4, *p* = 0.03). Hygiene, xerostomia, mucositis, and occlusion had the highest correlation to detection of pneumonia-causing bacteria. Using ROC analysis, a cut-off point of 4 proved to be most valid for oral assessment aiming to detect pneumonia-causing bacteria.

Conclusions: The point oral exam was validated for detection of pneumonia-causing bacteria. If the cut-off point was ≥4, the chance of detecting pneumonia-causing bacteria was high; therefore, clinical staff should positively intervene on patient’s oral health.

Abbreviations: Aspiration-pneumonia (AP)

Point rating system of the bedside oral exam (point oral exam)

Introduction

Oral bacterial pathogens can cause not only dental and periodontal disease but also serious systemic diseases (1, 2). Oral intake of food and drink is required for maintaining quality of life; meanwhile, inferior oral hygiene may lead to aspiration pneumonia (AP) (3, 4). In 2013 pneumonia was reported the third most common fatal disease in Japanese people by The Ministry of Wealth, Labour and Welfare in Japan (5). Moreover, nosocomial pneumonia accounts for approximately 10–15% of all hospital-acquired infections, and 20–50% of affected patients die because of the infection (2). It has been reported that the amount of bacteria aspirated is a major factor in the development of pneumonia (6). The oral cavity may constitute a reservoir of pathogens responsible for aspiration pneumonia in high-risk patients. Oral hygiene, including professional oral care, has been shown to reduce the amount of bacteria in the oral cavity (7), and daily oral care has been shown to decrease the frequency of fever (8) and pneumonia-related mortality rate in the elderly (9). Without doubt, oral health assessment, management, and care in patients with head and neck cancer and patients in a state of malnutrition important, and a matter of intervention and support for nutritional support teams (NST) (10, 11).

Despite strong literature-based evidence highlighting the role of oral care in the prevention of AP, to the best of our knowledge, no study has reported on the correlation between point rating systems of oral health assessment (point oral exam) and the existence of pneumonia-causing bacteria. In this study, point oral exams were conducted at each patient’s bedside by nutrition support teams, and we carried out a randomized trial to identify the relation between point oral exam and the detection of pneumonia-causing bacteria, and to examine whether oral health assessment scores correlate with pneumonia by bacterial infection in hospitalized patients.

Study population and methodology:

Of 61 patients who received intervention by the NST from January 1, 2013 to June 30, 2013, 55 patients were included in this study. Six patients were excluded because of their underlying disease being exacerbated to the extent where this type of intervention did not appear relevant. Table 1 displays the patient data and laboratory values, including gender, BMI, WBC, Hb, lymph cells, albumin, and transthyretin. Oral health assessment was performed by a single dentist, who was blinded to the results of the laboratory tests, including culture tests for pneumonia-causing bacteria, and who evaluated and recorded the scores of the point oral exam using our original oral health assessment panel (Fig.1).

In this study, we targeted the following eight species of pneumonia-causing bacteria, all of which are strongly associated with pneumonia (12-14): *Staphylococcus aureus* (MSSA), *Staphylococcus aureus* (MRSA), *Klebsiella pneumonia*, *Pseudomonas aeruginosa*, *Enterobacter cloacae*, *Escherichia coli*, *Haemophilus Influenzae*,and *Streptococcus pneumoniae*.

The detection group consisted of the 13 patients in whom one or more of these eight species were detected, and similarly, the non-detection group comprised the 42 patients in whom none of these bacteria were detected. The clinical microbiology laboratory of our hospital performed the bacterial analyses as a third party and in neutral way, blinded to the results and scores of the oral health assessments. Professionals not involved in the oral assessment or laboratory tests performed the statistical analyses. Thus, this study was performed as a blinded, prospective study.

Point oral exams were carried out once by NST. The assessment did not give rise to additional inspection or inflicting pain on patients, enabled sharing of information with medical staff, e.g., with regard to bacteriological examination of respiratory secretions, and the oral health assessment was beneficial also for management of therapeutic strategies. The study was performed in accordance with the Declaration of Helsinki and made under the provisions of the institutional review board at Kanazawa University Hospital. Patients were free to withdraw from the study at their own free will at any time. Informed consent was obtained from all study individuals and recorded in their respective case report forms. Our original oral assessment system (point oral examination) was decided by reference to a number of other methods of oral assessment such as Eilers’ Oral Assessment Guide and the revised oral assessment guide in order to share efficient and effective information of patient’s oral hygiene with medical staff (2, 15, 16). The point oral exam has been used as a measure of oral health for patients attended to by NST. The point scale ranges from 0 point (excellent oral health) to 12 point (extremely poor oral health). The assessment comprises four items for evaluation, namely hygiene, xerostomia, mucositis, and occlusion (Fig.1).

Statistical analyses

Welch’s *t*-test was used to determine significant differences in clinical data between the detection group and the nondetection group. Fisher’s exact test was used to determine significant differences between scores of point oral exams of the detection group and that of nondetection group regarding each of the four items. The cut-off point distinguishing the detection group and nondetection group was decided by ROC analysis. All statistical analyses were performed using Stata 12.1 (Stata Corp, College Station, TX). Differences were considered statistically significant at probability (*p*) values of <0.05.

Results

Blood test results and patient data, including age, sex, and BMI, were examined for both the detection group and the nondetection group (Table 1); no significant differences were observed between the two.

The total point oral exam scores of the detection group (n = 13) were significantly lower than the total scores of the nondetection group (n = 42) (5.4 ± 0.7 vs. 3.4 ± 0.4, *p* = 0.03) (Fig. 2).

The first item, “hygiene”, especially showed the strongest correlation with detection of pneumonia-causing bacteria among the four items, and scores in “hygiene” were higher in the detection group than in the nondetection group (1.8 ± 0.3 vs. 0.9 ± 0.2, *p* = 0.03) (Fig. 3). The detection group also scored worse on “mucositis” and “occlusion” compared with the nondetection group (“mucositis,” 0.7 ± 0.3 vs. 0.3 ± 0.1, *p* = 0.19; “occlusion,” 1.9 ± 0.4 vs. 1.1 ± 0.2, *p* = 0.09), although the differences were not significant (Fig. 4,5). As for “xerostomia,” there was no difference in the scores of the two groups (1.1 ± 0.3 vs. 1.1 ± 0.2, *p* = 0.99) (Fig. 6). Evaluation scores of “mucositis” were consistently lowest among the four items.

Finally, a point cut-off of 4 or more, was identified by ROC analysis as valid for distinguishing between patients with pneumonia-causing bacteria and those without (Fig.7).

Discussion

There are reports that by practicing good oral care, pneumonia incidence rates can be reduced by 40%, with mortality rates further dropping 10% (17). In addition, there are reports on oral care in ventilator management lowering the incidence of ventilator-associated pneumonia (18).

In this study, it became clear that the detection rate of pneumonia-causing bacteria increased as scores on “hygiene” or total scores of the point oral exam increased. These results were assumed reasonable because many studies have reported oral cleaning care as an effective tool in the suppression and prevention of aspiration pneumonia (14, 19).

In addition, although there was no significant difference, the detection group scored worse on “occlusion” than the nondetection group. Taking these results into account, oral care and hygiene are obviously necessary to prevent aspiration pneumonia, but also sufficient quantities of saliva, absence of mucositis, and good occlusion is important to maintain the health of the oral cavity and general physical condition. As an example, Holm-Pedersen et al. reported that loss of teeth brings about bite and chewing dysfunctions, risk of aspiration, and increase in malnutrition (20). In addition, other researchers pointed out that loss of teeth was associated with dementia and low nutrient conditions, thus being a prognostic factor of poor overall health (21, 22). A greater number of existing teeth in a subject is linked to higher nutritional intake even with the same nutrition consumption (23). Oral health status, nutrition status, and food intake are closely related, affecting whole-body health (24, 25). Furuta et al. reported that a lower number of teeth was positively related to swallowing dysfunction, whereas denture wearing contributed to recovery of swallowing functions (21). Therefore, unfavorable occlusal status may eventually lead to aspiration pneumonia by aspiration of saliva and food under unsanitary condition.

The detection group similarly scored worse on “mucositis” than the nondetection group, whereas for “xerostomia,” somewhat identical scores in the two groups were observed. Other researchers reported that evaluation and management of mucositis are required to proceed to oral ingestion and improved QOL (26, 27), whereas association between detection of pneumonia-causing bacteria and xerostomia was not reported at all in previous clinical research. As a consequence, a role for xerostomia in the potential development of pneumonia could not be identified.

ROC analysis indicated that a cut-off of 4 points was useful for distinguishing the detection group from the nondetection group. Clinical application of the cut-off, despite moderate sensitivity and specificity (77% and 55%, respectively) might be useful to conduct screening tests of the risk of developing AP, because of the higher detection rate of pneumonia-causing bacteria when a score of ≥4 was observed.

Another oral health assessment method, the Eilers’ Oral Assessment Guide, is one of the most famous oral health assessment methods and is commonly used at other institutions (15), but this assessment system requires more time with regard to assessing the various items. Because such methods were too complicated to apply to patients in poor general condition, and because limited time was available for NST, we used this original oral health assessment method which is relatively simple.

However, there were some issues in terms of evaluating the clinical application of this study. This study was only performed in our own facilities, and the number of patients included was relatively small. Further randomized trials are needed to confirm our results and to validate point rating systems.

Conclusion

The original point system of bedside oral exam is correlated with the detection of pneumonia causing bacteria. Therefore, it may be suggested that the use of our original assessment sheet is relevant for assessing oral health, especially when only limited time and resources are available.

**Clinical relevance**

**Scientific rationale for study**

All data obtained in our research was processed blindly so that there is no bias as possible.

**Principal findings**

Our finding that the point oral exam (cut-off point: ≥4) was validated for detection of pnemounia-causing bacteria. It may be suggested that the use of our original assessment sheet is relevant for assessing oral health, especially when only limited time and resources are available.

**Practical implications**

Clinical staff should positively intervene on patient’s oral health with best suited personalized oral hygiene tools in case of cut-off point ≥4.

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Conflict of interest

None

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Figure　Legends

Figure 1

Each of four items evaluated (“hygiene,” “xerostomia,” “mucositis,” and “occlusion”) received a score from 0 (excellent assessment) to 3 points (poor assessment). The total score ranged from 0 points (excellent oral health) to 12 points (very poor oral health).

Figure 2

The group (n = 13) of patients in whom pneumonia-causing bacteria were found (detection group) had significantly lower total scores in the point oral exam than those in the nondetection group (n = 42) (5.4 ± 0.7 vs. 3.4 ± 0.4). \* *P* < 0.05

Figure 3

The first item, “hygiene,” in the point oral exam exhibited the strongest correlation with detection of pneumonia-causing bacteria; hence “hygiene” scores were significantly higher in the detection group than in the nondetection group (1.8 ± 0.3 vs. 0.9 ± 0.2). \* *P* < 0.05

Figure 4

The detection group (n = 13) scored worse on “mucositis” than the nondetection group (n = 42) (0.7 ± 0.3 vs. 0.3 ± 0.1, *p* = 0.19), although the difference was not significant.

Figure 5

The detection group (n = 13) scored worse on “occlusion” than the nondetection group (n = 42) (1.9 ± 0.4 vs. 1.1 ± 0.2, *p* = 0.09); however, the difference was not significant.

Figure 6

There was no difference in score on “xerostomia” between the detection group and the nondetection group (1.1 ± 0.3 vs. 1.1 ± 0.2, *p* = 0.99).

Figure 7

ROC analysis suggested that a cut-off point of ≥4 classified patients as in risk of having pneumonia-causing bacteria with a sensitivity of 77% and a specificity of 55%. Area Under the Curve (AUC) was 0.71 which indicated moderate accuracy.