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Pneumonia and the role of dentistry on ICU Staff: 8-year analysis of health indicators

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Abstract: Ventilator-associated pneumonia (VAP) is one of the most prevalent healthcare-associated infections (HAI) and causes of death in intensive care units (ICUs), and studies have shown its relation to oral health. **Aim:** To report the impact of the incorporation of dental professionals into multidisciplinary ICU staff on the incidence of VAP. **Methods:** A retrospective observational study was carried out to collect and analyze health indicators of patients in the ICUs from 2011 to 2018 and to differentiate these indicators between the periods before and after the participation of dental staff in the ICU. This study was approved by the Research Ethics Committee. **Results:** The average number of monthly ICU admissions was 105.89 ± 169.72, and the discharge was 105.21 ± 168.96, with a monthly average number of deaths within 24 h of 38.61 ± 62.27. The average number of monthly HAI-related deaths decreased from 2011 to 2018, followed by a reduction in cases of HAI per month. The average monthly number of HAIs related to mechanical ventilation (MV) decreased, and the same was observed for the infection density of HAIs related to MV ($p < 0.001$). In multivariate analysis, there was a significant decrease in the number of HAIs related to MV ($p = 0.005$). **Conclusion:** Although a reduction in the number of admissions or complexity of cases was not observed in the study period, multidisciplinary staff practices were essential for controlling HAIs and the presence of dental professionals can assist in the control of HAIs related to MV.

Keywords: Respiration, artificial. Pneumonia, ventilator-associated. Dentistry.

Introduction

In Brazil, intensive care was implemented in the 1970s. This measure brought about a substantial decrease in the number of deaths in intensive care units (ICUs)[1] and reduced the number of healthcare-associated infections (HAIs), which are among the main causes of increased length of stay in ICUs and the incidence of death during hospitalization[2].

Lack of attention to oral hygiene and reduced salivary flow in ICU patients increases the complexity and amount of biofilm, which can favor the interaction between indigenous plaque bacteria and respiratory pathogens such as *P. aeruginosa* and enteric gram-negative bacilli. Contamination of the lower respiratory tract by saliva can cause respiratory infections[3].

Perhaps one of the most important contributions of dental professionals to the hospital environment is the prevention of ventilator-associated pneumonia (VAP). VAP remains a major cause of morbidity and mortality, and it also increases the cost of care for critically ill patients[2,4-6]. The incidence of VAP ranges from 6% to 52%; in ICUs, it represents 25% of all infections. Unquestionably, intubation is associated with an increased risk; approximately 90% of VAP episodes in ICUs occur in patients on mechanical ventilation (MV)[7]. Despite a study that showed mortality rates of 50% in patients who develop VAP[8]; on average, death occurs in 10% of cases[4].

The native oral microbiota plays an important role in the risk of VAP development. Abnormal colonization and presence of potential respiratory pathogens in biofilms are among the main etiological causes[9,10]. Pathogen migration occurs when patients aspirate contaminated oropharyngeal secretion, which disseminates through spaces between the trachea and tracheal tube cuff[7]. Other variables affecting this outcome are possible systemic disabilities caused by antibiotic use, stress, chronic respiratory diseases, gastroesophageal reflux, and immunosuppression[11].

Controlling the oral microbiota has a relevant effect on VAP prevention[4]. Among the applicable methodologies, chemical control with chlorhexidine gluconate (CHX) associated with mechanical cleaning of mucous and dental surfaces has a significant impact on reducing these infectious conditions[5].

Oral care in the ICU is provided by nurses and deemed of moderate-to-high importance compared with other care activities[12]. DeKeyser Ganz et al.[13] (2009) showed that no consistent practices related to oral care existed, and that most nurses had little or no knowledge of the current best evidence-based practice[13].

This paper aims to report the impact of the incorporation of dental professionals into multidisciplinary ICU staff on the incidence of VAP. This topic is significant for dentistry because it could offer subsidies for programs aimed at improving the multidisciplinary treatment offered to the patients. In addition, it could reduce treatment costs related to patients in critical care.

Materials and methods

This was a retrospective and observational study of hospital indicator data on ICU occupation and healthcare-associated infections from 2011 to 2018. The study was

carried out in a general hospital with 3 ICUs (a total of 21 beds), and where the patients were treated and followed by a multidisciplinary staff that incorporated a team of dental professionals in 2014. This addition to the staff was the main subject of the present investigation.

The ICUs receive adult patients with several medical conditions, such as community-acquired pneumonia, chronic obstructive pulmonary disease, stroke, exogenous intoxication, and pancreatitis, among others.

Every month, the Committee on Infectious Disease Control and Prevention monitors and records infectious events and uploads the information to an electronic database. This information was consulted to gather the following data for the present study: number of ICU admissions and discharges, number of patients discharged from the ICUs to regular nursing floors or transferred to other hospitals, number of ICU deaths in the first 24 h, number of HAI-related deaths, number of HAI cases, number of HAI patients, number of MVs/day (MV/d), number of HAIs related to MV, and infection density of HAIs related to MV.

The infection density of HAIs related to MV was calculated using the ratio between the number of reported pulmonary infections and the number of ventilations/day ×1 000.

As the primary hypothesis of the present study, it was supposed that the presence of an oral health team would reduce the number of HAI related to MV in critical patients. This impact would be associated with the quality and frequency of oral hygiene performed.

The VAP prevention bundle is an institutional recommendation that has five steps to be performed in patients under MV. The recommendations are: peptic ulcer prevention, daily sedation interruption, elevated headboard, prevention of thromboembolic events, and oral hygiene. It was the same before and after 2014, but before 2014, the nursing team was the only one responsible for performing these procedures. With the multidisciplinary staff improvement, one dental hygienist and one dentist (qualified in hospital dentistry) were responsible for helping with the oral hygiene essential procedure. Before and after 2014, the oral hygiene protocol was exactly the same; the only difference was the presence of dental specialists evaluating and training the nurses on oral hygiene, mainly for patients on MV. The dental staff also had as objective to perform oral examinations of all the patients referred to the ICU, identifying oral lesions or treatment necessities.

As an important landmark to evaluate this impact on the HAIs related to MV, the data from 2011-2014 were compared to that from 2015-2018.

The collected data were tabulated in an Excel spreadsheet and exported to the Statistical Package for the Social Sciences (SPSS) software for statistical analysis. Monthly rates were compared by year using Pearson's correlation test. In addition, the multiple linear regression model was employed to assess the collinearity between the data and the temporal profile as well as the number of HAIs. All analyses were performed using the 95% confidence interval in the SPSS software.

This study was submitted and approved by the Research Ethics Committee under protocol 1,418,708.

Results

To present the number of patients treated in the ICUs in this study, Table 1 shows information about the number of ICU admissions and discharges, and the main reasons for discharge (transfer to nursing floors and transfer to other hospitals). The average number of monthly admissions in the study period was 105.89 ± 169.72, and discharge was 105.21 ± 168.96, with the transfer to a regular nursing floor as the most frequent reason (60.98 ± 96.87).

Table 1. General data from 2011-2014 and 2015-2018.

	Period		Total	p-Valor
	2011-2014	2015-2018		
Number of ICU admissions	100.02±160.05	111.65±180.08	105.89±169.72	0.730
Number of ICU discharges	98.69±158.45	111.73±180.17	105.21±168.96	0.696
Transfer to nursing floors	58.98±94.34	63.02±100.29	60.98±96.87	0.834
Transfer to other hospitals	2.77±5.00	5.61±9.69	4.17±7.78	0.066
ICU Deaths (24h)	35.56±58.14	41.73±66.66	38.61±62.27	0.618
HAI - related deaths	7.69±20.05	7.35±28.99	7.52±24.80	0.944
Total HAI	22.08±35.63	19.85±34.13	20.96±34.73	0.745
Number of HAI patients	19.04±30.70	17.73±29.89	18.38±30.16	0.826
Number of mechanical ventilation/day	872.43±1438.35	864.94±1383.03	868.69±1404.10	0.978
Number of HAI-related to MV	6.35±10.29	3.77±6.70	5.06±8.74	0.133
MV-related to HAI density	7.15±3.52	4.41±3.64	5.78±3.82	***<0.001**

*p<0.05, t de Student test, data expressed as mean ± SD. MV – Mechanical ventilation; HAI - Healthcare-associated infection.

To show the severity level of the treated patients, Table 1 shows the average number of deaths within the first 24 h and the HAI-related deaths. It is important to highlight that the average number of monthly HAI-related deaths decreased from 7.69 ± 20.05 to 7.35 ± 28.99 after 2015.

The infection data collected (HAI-related deaths; total HAI; number of HAI patients) showed that despite an increase in the average number of deaths between the periods, there was a reduction in the cases of HAI per month from 22.08 ± 35.63 to 19.85 ± 34.13 (Table 1).

Considering the information on HAI of the respiratory tract (number of MV/day; number of HAI related to MV; MV-related to HAI density), Table 1 also shows that the average monthly number of MV/d slightly reduced between the periods, the same as HAIs related to MV that decreased with a more expressive numeric change. However, only the reduction in the MV-related to HAI density was statistically significant ($p < 0.001$).

In multivariate analysis, it is important to highlight that there was a reduction in the number of HAIs related to MV ($p = 0.005$) from 2011 to 2018 (Table 2). This analysis means that it was independent from the other data tabulated.

Table 2. Multivariate analysis

Year	p-Value	β ajusted	CI 95%	
Number of ICU admissions	0.659	-0.037	-0.205	0.130
Number of ICU discharges	0.650	-0.044	-0.235	0.148
Transfer to nursing floors	0.563	0.030	-0.072	0.132
Transfers to other hospitals	***0.015**	**0.223**	**0.044**	**0.402**
ICU deaths within 24 hours	***0.043**	**0.128**	**0.004**	**0.252**
HAI-related deaths	0.991	0.000	-0.036	0.035
Total number of HAI	0.981	0.004	-0.282	0.289
Number of patients with HAI	0.739	0.058	-0.285	0.400
Number of MV/day	0.666	0,001	-0.003	0.005
Number of HAI associated with MV	***0.005**	**-0.283**	**-0.479**	**-0.088**
MV-related to HAI density	0.500	-0.002	-0.006	0.003

*p<0.05, multiple linear regression.
ANOVA / Bonferroni test; Pearson's correlation [p-value (Pearson's correlation coefficient)]. Data expressed as mean ± SD. MV – Mechanical vetilation; HAI - Healthcare-associated infection

Discussion

Hospital infections are potential life-threatening conditions for patients in ICUs and are among the main causes of hospital morbidity and mortality[14]. Throughout the study period, there was a reduction in the total number of nosocomial infections, which might result from an increase in quality of care, especially after the incorporation of dental professionals into the multidisciplinary staff.

Almost half of the microorganisms in the human body are found in the oral cavity[15]. These organized microorganisms form biofilms that can be colonized by potential respiratory pathogens[9]. Therefore, it is important to pay attention to oral hygiene and to invest in professionals trained for this function. Moreover, the acquisition of components related to mechanical and chemical control of dental biofilm appears to be a necessary measure for maintaining the health of hospitalized patients[16].

Matos et al.[16] (2013) conducted a national survey on physicians working in ICUs with questionnaires addressing the participation of dentists in the hospital environment. The results showed that 83.68% of the physicians did not supervise the oral hygiene of patients, 76.52% did not indicate the use of mouthwash in their patients, and most physicians were unable to diagnose oral conditions such as periodontal disease (93.88%) and dental caries (84.7%). The work by Matos et al.[16] (2013) highlights the importance of the participation of dentists in the hospital environment to minimize systemic problems resulting from oral conditions, mainly because this is not a specific concern of ICU physicians.

DeKeyser Ganz et al.[13] (2009) conducted a survey with nurses working in ICUs asking about the current oral care practices performed for patients, including the type of equipment used, solutions used, technique, and the type and timing of oral assessment. Nurses were also asked about their perceived level of priority for oral care on a scale from 0 to 100. The authors showed that nurses were often not adhering to the latest evidence-based practice on oral hygiene and therefore need to be educated and

encouraged to do so to improve patient care. Only 44% of the sample brushed their patients' teeth. This is a significant health care problem, and is not only present in Israel as shown by DeKeyser Ganz et al.[13] (2009). The data of the present study shows that without the participation and action of a dental staff, the ICU patients did not have adequate oral hygiene, which had a positive impact on MV-related pneumonia.

Moreover, as cited by Alhazzani et al.[12] (2013), a high workload makes nurses give more attention or importance to other critical necessities of ICU patients. The results of the cited literature agree with the present study, considering that the results presented here show the benefits of oral health care provided by a dental team. Both the literature and the results presented highlight the necessity of having dental professionals included in the multidisciplinary staff of critical patients.

The addition of dental professionals to the multidisciplinary staff leads to a significant reduction in the length of stay on MV[17]. This may be a consequence of the implementation of a daily oral hygiene routine, reducing oral contamination. However, there is still no consensus on an oral hygiene protocol that can be implemented to reduce infections related to MV. In general, CHX, liquid or gel, 0.12% or 0.2%, three or four times a day[9,18] is the most used method[19]. Oral antisepsis demonstrates efficacy in controlling oral biofilms in patients exposed to long periods of MV[20,21]. A review published on the Cochrane platform concluded that the use of CHX, whether in liquid or gel form, is associated with a 40% reduction in the occurrence of VAP in critically ill adult patients[22]. Nonetheless, larger studies are still needed to verify the impact of these practices on hospital indicators[23].

However, as stated by Prasad et al.[24] (2009), it is difficult to ascertain whether the significant improvement in oral hygiene found in their study was due to chlorhexidine use or the improved technique of the ward staff or, indeed, both factors combined. The author also said that the training element should not be underestimated when having dental staff in the ICU. This is one more reason to support that the better the staff the better the care provided, considering the stimulus of one person to another on the care provided to the patients.

This study analyzed a vast database and demonstrated the importance of controlling infections caused by MV, demonstrating that the incorporation of dental professionals in high complexity hospitals can contribute to the control of HAI. The results of the multivariate analysis showed that although there was an increase in the number of deaths (within 24 h) in the study period, a reduction of approximately 28% per year in the number of HAIs related to MV was achieved. In summary, despite the increase in complexity of critical patients, the actions implemented to improve care influenced the control of nosocomial infections, especially in relation to oral health.

The dentist's role in areas with a high prevalence of VAP, such as in ICUs, is important to ensure adequate oral hygiene for patients and to help reduce intubation time, length of stay, and mortality[21]. The data from the present research highlight that after the incorporation of dental professionals in 2014, there was a significant decrease in the density of HAIs related to MV from 7.15 ± 3.52 between 2011 and 2014 to 4.41 ± 3.64 between 2015 and 2018. This reveals that the presence of dental professionals can improve oral health even when a nursing staff is already responsible for oral healthcare.

It should also be noted that VAP occurrences increase hospitalization costs; however, economic values have not yet been quantified because of the numerous variables involved in the process[4]. There are few available data on the cost reduction that hospital dentistry can generate in high complexity hospitals. Nevertheless, the most significant reduction is probably the improvement of indicators related to MV[17]. This economic impact should be investigated in future studies.

In conclusion, although a reduction in the number of admissions or complexity of cases was not observed in the study period, the data of the present study reinforce that the practices conducted by the multidisciplinary staff were essential for the control of HAIs and that the presence of dental professionals can assist in the control of HAIs related to MV.

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References

1. do Nascimento ER, Trentini M. [Nursing care at the intensive care unit (ICU): going beyond objectivity]. Rev Lat Am Enfermagem. 2004 Mar-Apr;12(2):250-7. Portuguese. doi: 10.1590/s0104-11692004000200015.

2. Munro CL, Grap MJ, Sessler CN, Elswick RK Jr, Mangar D, Karlnoski-Everall R, et al. Preintubation application of oral chlorhexidine does not provide additional benefit in prevention of early-onset ventilator-associated pneumonia. Chest. 2015 Feb;147(2):328-34. doi: 10.1378/chest.14-0692.

3. Gomes SF, Esteves MCL. [Role of the surgeon dentist in ICU: a new paradigma]. Rev Bras Odontol. 2012;69(1):67-70. Portuguese.

4. Klompas M, Branson R, Eichenwald EC, Greene LR, Howell MD, Lee G, et al. Strategies to prevent ventilator-associated pneumonia in acute care hospitals: 2014 update. Infect Control Hosp Epidemiol. 2014 Aug;35(8):915-36. doi: 10.1086/677144.

5. Lorente L, Lecuona M, Jiménez A, Palmero S, Pastor E, Lafuente N, et al. Ventilator-associated pneumonia with or without toothbrushing: a randomized controlled trial. Eur J Clin Microbiol Infect Dis. 2012 Oct;31(10):2621-9. doi: 10.1007/s10096-012-1605-y.

6. Koeman M, van der Ven AJ, Hak E, Joore HC, Kaasjager K, de Smet AG, Ramsay G, Dormans TP, Aarts LP, de Bel EE, Hustinx WN, van der Tweel I, Hoepelman AM, et al. Oral decontamination with chlorhexidine reduces the incidence of ventilator-associated pneumonia. Am J Respir Crit Care Med. 2006 Jun 15;173(12):1348-55. doi: 10.1164/rccm.200505-820OC.

7. Wang J, Liu KX, Ariani F, Tao LL, Zhang J, Qu JM. Probiotics for preventing ventilator-associated pneumonia: a systematic review and meta-analysis of high-quality randomized controlled trials. PLoS One. 2013 Dec 18;8(12):e83934. doi: 10.1371/journal.pone.0083934.

8. Needleman IG, Hirsch NP, Leemans M, Moles DR, Wilson M, Ready DR, et al. Randomized controlled trial of toothbrushing to reduce ventilator-associated pneumonia pathogens and dental plaque in a critical care unit. J Clin Periodontol. 2011 Mar;38(3):246-52. doi: 10.1111/j.1600-051X.2010.01688.x.

9. Özçaka Ö, Başoğlu OK, Buduneli N, Taşbakan MS, Bacakoğlu F, Kinane DF. Chlorhexidine decreases the risk of ventilator-associated pneumonia in intensive care unit patients: a randomized clinical trial. J Periodontal Res. 2012 Oct;47(5):584-92. doi: 10.1111/j.1600-0765.2012.01470.x.

10. Charles MP, Easow JM, Joseph NM, Ravishankar M, Kumar S, Sivaraman U. Aetiological agents of ventilator-associated pneumonia and its resistance pattern - a threat for treatment. Australas Med J. 2013 Sep 30;6(9):430-4. doi: 10.4066/AMJ.2013.1710.

11. American Thoracic Society; Infectious Diseases Society of America. Guidelines for the management of adults with hospital-acquired, ventilator-associated, and healthcare-associated pneumonia. Am J Respir Crit Care Med. 2005 Feb;171(4):388-416. doi: 10.1164/rccm.200405-644ST.

12. Alhazzani W, Smith O, Muscedere J, Medd J, Cook D. Toothbrushing for critically ill mechanically ventilated patients: a systematic review and meta-analysis of randomized trials evaluating ventilator-associated pneumonia. Crit Care Med. 2013 Feb;41(2):646-55. doi: 10.1097/CCM.0b013e3182742d45.

13. DeKeyser Ganz F, Fink NF, Raanan O, Asher M, Bruttin M, Nun MB, Benbinishty J. ICU nurses' oral-care practices and the current best evidence. J Nurs Scholarsh. 2009;41(2):132-8. doi: 10.1111/j.1547-5069.2009.01264.x.

14. Laupland KB, Zygun DA, Doig CJ, Bagshaw SM, Svenson LW, Fick GH. One-year mortality of bloodstream infection-associated sepsis and septic shock among patients presenting to a regional critical care system. Intensive Care Med. 2005 Feb;31(2):213-9. doi: 10.1007/s00134-004-2544-6.

15. AMARAL SM, CORTES AQ, PIRES FR, Pneumonia nosocomial: importância do microambiente oral. J Bras Pneumol. 2009;35(11)1116-24. doi: 10.1590/S1806-37132009001100010.

16. Matos FZ, Porto NA, Caporossi LS. Semenoff TADV, Borges AH, Segundo AS. Hospital Physicians' knowledge of oral hygiene and oral manifestations in hospitalized patients. Pesq Bras Odontoped Clin Integr. 2013;13(3):239-43. doi: 10.4034/PBOCI.2013.133.03.

17. de Souza IS, Santaella NG, da Silva Santos PS. The practice of hospital dentistry in Brazil: an integrative literature review. Rev Bras Odontol. 2017;74(3):232-9. doi: 10.18363/rbo.v74n3.p.232.

18. Fourrier F, Dubois D, Pronnier P, Herbecq P, Leroy O, Desmettre T, Pottier-Cau E, Boutigny H, Di Pompéo C, Durocher A, Roussel-Delvallez M; PIRAD Study Group. Effect of gingival and dental plaque antiseptic decontamination on nosocomial infections acquired in the intensive care unit: a double-blind placebo-controlled multicenter study. Crit Care Med. 2005 Aug;33(8):1728-35. doi: 10.1097/01.ccm.0000171537.03493.b0.

19. Bergan EH, Tura BR, Lamas CC. Impact of improvement in preoperative oral health on nosocomial pneumonia in a group of cardiac surgery patients: a single arm prospective intervention study. Intensive Care Med. 2014 Jan;40(1):23-31. doi: 10.1007/s00134-013-3049-y.

20. Bellissimo-Rodrigues WT, Menegueti MG, Gaspar GG, de Souza HCC, Auxiliadora-Martins M, Basile-Filho A, et al. Is it necessary to have a dentist within an intensive care unit team? Report of a randomised clinical trial. Int Dent J. 2018 Dec;68(6):420-7. doi: 10.1111/idj.12397.

21. Tuon FF, Gavrilko O, Almeida S, Sumi ER, Alberto T, Rocha JL, et al. Prospective, randomised, controlled study evaluating early modification of oral microbiota following admission to the intensive care unit and oral hygiene with chlorhexidine. J Glob Antimicrob Resist. 2017 Mar;8:159-63. doi: 10.1016/j.jgar.2016.12.007.

22. Shi Z, Xie H, Wang P, Zhang Q, Wu Y, Chen E, Ng L, Worthington HV, Needleman I, Furness S. Oral hygiene care for critically ill patients to prevent ventilator-associated pneumonia. Cochrane Database Syst Rev. 2013 Aug 13;(8):CD008367. doi: 10.1002/14651858.CD008367.pub2. Update in: Cochrane Database Syst Rev. 2016 Oct 25;10 :CD008367.

23. Scannapieco FA, Yu J, Raghavendran K, Vacanti A, Owens SI, Wood K, Mylotte JM. A randomized trial of chlorhexidine gluconate on oral bacterial pathogens in mechanically ventilated patients. Crit Care. 2009;13(4):R117. doi: 10.1186/cc7967.

24. Prasad R, Daly B, Manley G. The impact of 0.2% chlorhexidine gel on oral health and the incidence of pneumonia amongst adults with profound complex neurodisability. Spec Care Dentist. 2019 Sep;39(5):524-32. doi: 10.1111/scd.12414.