

Full Text Options



Save to Other File Formats

Add to Marked List

## Monospecies and polymicrobial biofilms differentially regulate the phenotype of genotype-specific oral cancer cells

By: [Arzmi, MH](#) (Arzmi, Mohd Hafiz)<sup>[1,2]</sup>; [Cirillo, N](#) (Cirillo, Nicola)<sup>[1]</sup>; [Lenzo, JC](#) (Lenzo, Jason C.)<sup>[1]</sup>; [Catmull, DV](#) (Catmull, Deanne V.)<sup>[1]</sup>; [O'Brien-Simpson, N](#) (O'Brien-Simpson, Neil)<sup>[1]</sup>; [Reynolds, EC](#) (Reynolds, Eric C.)<sup>[1]</sup>; [Dashper, S](#) (Dashper, Stuart)<sup>[1]</sup>; [McCullough, M](#) (McCullough, Michael)<sup>[1]</sup>

[View ResearcherID and ORCID](#)

### CARCINOGENESIS

Volume: 40 Issue: 1 Pages: 184-193

DOI: 10.1093/carcin/bgy137

Published: JAN 2019

Document Type: Article

[View Journal Impact](#)

### Abstract

Oral cancer isolate *C.albicans*, *A.naeslundii* and *S.mutans* formed biofilms in flow environment which differentially modulated the malignant phenotype of oral keratinocytes in a paracrine manner.

Abstract Microbial infection has been shown to involve in oral carcinogenesis; however, the underlying mechanisms remain poorly understood. The present study aimed to characterize the growth of oral microorganisms as both monospecies and polymicrobial biofilms and determine the effects of their products on oral keratinocytes. *Candida albicans* (ALC3), *Actinomyces naeslundii* (AN) and *Streptococcus mutans* (SM) biofilms or a combination of these (TRI) were grown in flow-cell system for 24 h. The biofilms were subjected to fluorescent in situ hybridization using species-specific probes and analysed using confocal laser scanning microscopy. The effluent derived from each biofilm was collected and incubated with malignant (H357) and normal (OKF6) oral keratinocytes to assess extracellular matrix adhesion, epithelial-mesenchymal transition (EMT) and cytokines expression. Incubation of OKF6 with ALC3 and TRI effluent significantly decreased adhesion of the oral keratinocyte to laminin I, whereas incubation of H357 with similar effluent increased adhesion of the oral keratinocyte to laminin I, significantly when compared with incubation with artificial saliva containing serum-free medium (NE;  $P < 0.05$ ). In OKF6, changes in E-cadherin and vimentin expression were not consistent with EMT although there was evidence of a mesenchymal to epithelial transition in malignant oral keratinocytes incubated with AN and SM effluent. A significant increase of pro-inflammatory cytokines expression, particularly interleukin (IL)-6 and IL-8, was observed when H357 was incubated with all biofilm effluents after 2- and 24-h incubation when compared with NE ( $P < 0.05$ ). In conclusion, *C.albicans*, *A.naeslundii* and *S.mutans* form polymicrobial biofilms which differentially modulate malignant phenotype of oral keratinocytes.

### Keywords

**KeyWords Plus:** [CANDIDA-ALBICANS](#); [STREPTOCOCCUS-MUTANS](#); [INFLAMMATION](#); [EXPRESSION](#); [CYTOKINE](#); [BACTERIA](#); [CADHERIN](#); [MATRIX](#)

### Author Information

**Reprint Address:** Dashper, S; McCullough, M (reprint author)

+ Univ Melbourne, Melbourne Dent Sch, Oral Hlth Cooperat Res Ctr, 720 Swanston St, Carlton, Vic 3053, Australia.

### Addresses:

+ [ 1 ] Univ Melbourne, Melbourne Dent Sch, Oral Hlth Cooperat Res Ctr, 720 Swanston St, Carlton, Vic 3053, Australia

+ [ 2 ] Int Islamic Univ Malaysia, Kulliyah Dent, Dept Fundamental Dent & Med Sci, Kuantan, Pahang, Malaysia

**E-mail Addresses:** [stuartgd@unimelb.edu.au](mailto:stuartgd@unimelb.edu.au); [m.mccullough@unimelb.edu.au](mailto:m.mccullough@unimelb.edu.au)

### Funding

Funding Agency	Grant Number
OH-CRC, The University of Melbourne	
International Islamic University Malaysia, Kuantan, Pahang, Malaysia	RIGS17-083-0658

### Citation Network

In Web of Science Core Collection

0

Times Cited

[Create Citation Alert](#)

47

Cited References

[View Related Records](#)

### Use in Web of Science

Web of Science Usage Count

2

Last 180 Days

2

Since 2013

[Learn more](#)

This record is from:

Web of Science Core Collection  
- Science Citation Index Expanded

### Suggest a correction

*If you would like to improve the quality of the data in this record, please [suggest a correction](#).*

## Publisher

OXFORD UNIV PRESS, GREAT CLARENDON ST, OXFORD OX2 6DP, ENGLAND

## Categories / Classification

Research Areas: Oncology

Web of Science Categories: Oncology

## See more data fields

## Cited References: 47

Showing 30 of 47 [View All in Cited References page](#)

(from Web of Science Core Collection)

- 1. Coaggregation of *Candida albicans*, *Actinomyces naeslundii* and *Streptococcus mutans* is *Candida albicans* strain dependent** Times Cited: 13  
By: Arzmi, Mohd Hafiz; Dashper, Stuart; Catmull, Deanne; et al.  
FEMS YEAST RESEARCH Volume: 15 Issue: 5 Article Number: fov038 Published: AUG 2015
- 2. Polymicrobial biofilm formation by *Candida albicans*, *Actinomyces naeslundii*, and *Streptococcus mutans* is *Candida albicans* strain and medium dependent** Times Cited: 7  
By: Arzmi, Mohd Hafiz; Alnuaimi, Ali D.; Dashper, Stuart; et al.  
MEDICAL MYCOLOGY Volume: 54 Issue: 8 Pages: 856-864 Published: NOV 2016
- 3. *Streptococcus mutans* Can Modulate Biofilm Formation and Attenuate the Virulence of *Candida albicans*** Times Cited: 16  
By: Barbosa, Junia Oliveira; Rossoni, Rodnei Dennis; Godinho Vilela, Simone Furgeri; et al.  
PLOS ONE Volume: 11 Issue: 3 Article Number: e0150457 Published: MAR 2 2016
- 4. Suppression of alpha v beta 6 Integrin Expression by Polymicrobial Oral Biofilms in Gingival Epithelial Cells** Times Cited: 2  
By: Bi, Jiarui; Koivisto, Leeni; Pang, Aihui; et al.  
SCIENTIFIC REPORTS Volume: 7 Article Number: 4411 Published: JUN 30 2017
- 5. Expression of ABCG2 and Bmi-1 in oral potentially malignant lesions and oral squamous cell carcinoma** Times Cited: 16  
By: Dalley, Andrew J.; Pitty, Luke P.; Major, Aidan G.; et al.  
CANCER MEDICINE Volume: 3 Issue: 2 Pages: 273-283 Published: APR 2014
- 6. *Streptococcus mutans* biofilm disruption by kappa-casein glycopeptide** Times Cited: 4  
By: Dashper, Stuart G.; Liu, Sze-Wei; Walsh, Katrina A.; et al.  
JOURNAL OF DENTISTRY Volume: 41 Issue: 6 Pages: 521-527 Published: JUN 2013
- 7. Isolation and identification of *Candida* species in patients with orogastric cancer: susceptibility to antifungal drugs, attributes of virulence in vitro and immune response phenotype** Times Cited: 7  
By: de Sousa, Lourimar Viana Nascimento F.; Santos, Vera Lucia; Monteiro, Andrea de Souza; et al.  
BMC INFECTIOUS DISEASES Volume: 16 Article Number: 86 Published: FEB 23 2016
- 8. Regulation of Cadherin Trafficking** Times Cited: 95  
By: Delva, Emmanuella; Kowalczyk, Andrew P.  
TRAFFIC Volume: 10 Issue: 3 Pages: 259-267 Published: MAR 2009
- 9. IL-6 signaling contributes to cisplatin resistance in non-small cell lung cancer via the up-regulation of anti-apoptotic and DNA repair associated molecules** Times Cited: 28  
By: Duan, Shanzhou; Tsai, Ying; Keng, Peter; et al.  
ONCOTARGET Volume: 6 Issue: 29 Pages: 27651-27660 Published: SEP 29 2015
- 10. Immunohistochemical analysis of integrins alpha v beta 3, alpha v beta 5 and alpha 5 beta 1, and their ligands, fibrinogen, fibronectin, osteopontin and vitronectin, in frozen sections of human oral head and neck squamous cell carcinomas** Times Cited: 19  
By: Fabricius, Eva-Maria; Wildner, Gustav-Paul; Kruse-Boitschenko, Ute; et al.  
EXPERIMENTAL AND THERAPEUTIC MEDICINE Volume: 2 Issue: 1 Pages: 9-19 Published: JAN-FEB 2011

11. **Areca nut extracts mobilize calcium and release pro-inflammatory cytokines from various immune cells** Times Cited: 2  
By: Faouzi, Malika; Neupane, Ram P.; Yang, Jian; et al.  
SCIENTIFIC REPORTS Volume: 8 Article Number: 1075 Published: JAN 18 2018
12. **Role of Oral Microbial Infections in Oral Cancer.** Times Cited: 3  
By: Ferguson, Brett L; Barber, Scott; Asher, Imani H; et al.  
Dental clinics of North America Volume: 61 Issue: 2 Pages: 425-434 Published: 2017-04
13. **Candida albicans stimulates cytokine production and leukocyte adhesion molecule expression by endothelial cells** Times Cited: 89  
By: Filler, SG; Pfunder, AS; Spellberg, BJ; et al.  
INFECTION AND IMMUNITY Volume: 64 Issue: 7 Pages: 2609-2617 Published: JUL 1996
14. **Role of Type IV Collagen in Oral Squamous Cell Carcinoma.** Times Cited: 1  
By: Gouse, Sofia; Girish, H. C.; Sangamad, Rajeshwari  
RESEARCH JOURNAL OF PHARMACEUTICAL BIOLOGICAL AND CHEMICAL SCIENCES Volume: 7 Issue: 5 Pages: 2737-2741 Published: SEP-OCT 2016
15. **Effect of metabolic substances of oral Actinomyces on Candida albicans**  
**Efecto de sustancias metabolicas de Actinomyces orales sobre Candida albicans** Times Cited: 2  
By: Gutierrez de Annan, Susana; Benito de Cardenas, Laura  
Revista Iberoamericana de Micologia Volume: 21 Issue: 1 Pages: 29-34 Published: 2004
16. **Experimental reproducibility in flow-chamber biofilms** Times Cited: 471  
By: Heydorn, A; Ersboll, BK; Hentzer, M; et al.  
MICROBIOLOGY-UK Volume: 146 Pages: 2409-2415 Part: 10 Published: OCT 2000
17. **Role of hydrogen peroxide in competition and cooperation between Streptococcus gordonii and Actinomyces naeslundii** Times Cited: 60  
By: Jakubovics, Nicholas S.; Gill, Steven R.; Vickerman, M. Margaret; et al.  
FEMS MICROBIOLOGY ECOLOGY Volume: 66 Issue: 3 Pages: 637-644 Published: DEC 2008
18. **Fungi pathogenic to humans: molecular bases of virulence of Candida albicans, Cryptococcus neoformans and Aspergillus fumigatus** Times Cited: 107  
By: Karkowska-Kuleta, Justyna; Rapala-Kozik, Maria; Kozik, Andrzej  
ACTA BIOCHIMICA POLONICA Volume: 56 Issue: 2 Pages: 211-224 Published: 2009
19. **Mini-review: Microbial coaggregation: ubiquity and implications for biofilm development** Times Cited: 23  
By: Katharios-Lanwermyer, S.; Xi, C.; Jakubovics, N. S.; et al.  
BIOFOULING Volume: 30 Issue: 10 Pages: 1235-1251 Published: 2014
20. **Role of bacteria in oral carcinogenesis.** Times Cited: 5  
By: Khajuria, Nidhi; Metgud, Rashmi  
Indian journal of dentistry Volume: 6 Issue: 1 Pages: 37-43 Published: 2015 Jan-Mar
21. **Dynamic cell-matrix interactions modulate microbial biofilm and tissue 3D microenvironments** Times Cited: 15  
By: Koo, Hyun; Yamada, Kenneth M.  
CURRENT OPINION IN CELL BIOLOGY Volume: 42 Pages: 102-112 Published: OCT 2016
22. **Inflammation: Gearing the journey to cancer** Times Cited: 499  
By: Kundu, Joydeb Kumar; Surh, Young-Joon  
MUTATION RESEARCH-REVIEWS IN MUTATION RESEARCH Volume: 659 Issue: 1-2 Pages: 15-30 Published: JUL-AUG 2008
23. **Chronic Inflammation and Cytokines in the Tumor Microenvironment** Times Cited: 359  
By: Landskron, Glauben; De la Fuente, Marjorie; Thuwajit, Peti; et al.  
JOURNAL OF IMMUNOLOGY RESEARCH Article Number: 149185 Published: 2014
24. **Coaggregation between and among human intestinal and oral bacteria** Times Cited: 30  
By: Ledder, Ruth G.; Timperley, Andrea S.; Friswell, Melissa K.; et al.  
FEMS MICROBIOLOGY ECOLOGY Volume: 66 Issue: 3 Pages: 630-636 Published: DEC 2008

25. **A cytokine-mediated link between innate immunity, inflammation, and cancer** Times Cited: 1,098  
By: Lin, Wan-Wan; Karin, Michael  
JOURNAL OF CLINICAL INVESTIGATION Volume: 117 Issue: 5 Pages: 1175-1183 Published: MAY 2007
26. **IL-8, a novel messenger to cross-link inflammation and tumor EMT via autocrine and paracrine pathways (Review)** Times Cited: 19  
By: Long, Xinxin; Ye, Yingnan; Zhang, Lijie; et al.  
INTERNATIONAL JOURNAL OF ONCOLOGY Volume: 48 Issue: 1 Pages: 5-12 Published: JAN 2016
27. **Cell adhesion molecules, the extracellular matrix and oral squamous carcinoma** Times Cited: 74  
By: Lyons, A. J.; Jones, J.  
INTERNATIONAL JOURNAL OF ORAL AND MAXILLOFACIAL SURGERY Volume: 36 Issue: 8 Pages: 671-679 Published: AUG 2007
28. **twist is a potential oncogene that inhibits apoptosis** Times Cited: 394  
By: Maestro, R; Dei Tos, AP; Hamamori, Y; et al.  
GENES & DEVELOPMENT Volume: 13 Issue: 17 Pages: 2207-2217 Published: SEP 1 1999
29. **Oral yeast carriage correlates with presence of oral epithelial dysplasia** Times Cited: 68  
By: McCullough, M; Jaber, M; Barrett, AW; et al.  
ORAL ONCOLOGY Volume: 38 Issue: 4 Pages: 391-393 Article Number: PII S1368-8375(01)00079-3 Published: JUN 2002
30. **Infectious and dietary risk factors of oral cancer** Times Cited: 38  
By: Meurman, Jukka H.  
ORAL ONCOLOGY Volume: 46 Issue: 6 Pages: 411-413 Published: JUN 2010

**Showing 30 of 47**   [View All in Cited References page](#)

Clarivate

Accelerating innovation

© 2019 Clarivate   [Copyright notice](#)   [Terms of use](#)   [Privacy statement](#)   [Cookie policy](#)

[Sign up for the Web of Science newsletter](#)   [Follow us](#)

