INTERNATIONAL JOURNAL OF HEALTH & MEDICAL RESEARCH

ISSN(print): 2833-213X, ISSN(online): 2833-2148

Volume 04 Issue 04 April 2025

DOI : 10.58806/ijhmr.2025.v4i4n02

Page No. 212-215

Pathophysiology and Management of Balantidiasis: A Review Article

Mona Adel Ismail[1], Ali A. Al-fahham[2], Sara Abdulkhaliq Mahdi Abdulkarem Alfatlawi[3]

[1] Department of Medical Laboratory Techniques, Technical Institute / Kufa, Al-Furat Al-Awsat Technical University, Iraq

[2] Corresponding Author, Faculty of Nursing, University of Kufa, Iraq

[3] Department of community Health Techniques, Technical Institute of Babylon, Al-Furat Al-Awsat Technical University (ATU), Babylon, Iraq

ABSTRACT: Balantidiasis is caused by a protozoan parasite Balantidium coli. This is the only ciliate that has been discovered to infect humans and is most specifically associated with dysentery and general gastrointestinal disruption. Understanding its pathophysiology is important and larger applications for public health, especially in regions where sanitation is less than optimal. Knowledge on its management and epidemiology is very important in areas that have substandard sanitation and hygiene practices. This paper synthesizes the existing findings on the pathophysiology of balantidiasis, highlights the gaps in knowledge, and suggests future research directions. This paper also synthesizes existing research findings on the prevention and treatment of balantidiasis, highlights the gaps in knowledge, and suggests future research directions. To conclude, Balantidiasis reveals a complicated interplay between the pathogenic mechanisms of B. coli and the immune response of the host. Although much effort has been put into understanding its pathophysiology, more research is still called for to consider the existing gaps of knowledge. Future studies should focus on molecular interactions, gut microbiota, and socio-economic factors to open better ways for the effective prevention and treatment strategies against balantidiasis. How to manage and the epidemiology of Balantidiasis A multidisciplinary approach reflecting emergent knowledge across related fields of study is necessary. Only with further research in this area could gaps in knowledge regarding its pathogenic mechanisms and epidemiology be revealed. Such areas should be prioritized in future research so as to build up our capacity for understanding and controlling balantidiasis and thus improving the health outcomes of populations at risk.

INTRODUCTION

Balantidiasis is a protozoan infection. The only known ciliate to infect humans is presented by Balantidium coli and is principally associated with dysentery and other gastrointestinal disturbances. However, understanding its pathophysiology would be important in managing infection. This has wide implications for a public health problem, especially in regions of poor sanitation. Although many insights have been gathered into the pathophysiology of balantidiasis, many knowledge gaps still remain. Specifically, there are scanty details of the molecular interplay between B. coli and the host cells. In conclusion, it can be emphasized that Balantidium coli is an important protozoan parasite but under-researched; it has important implications for the public health of any given population. The present results should stimulate future research on this subject at the molecular level, which might be central to the development of better-targeted therapies for diseases caused by B. coli (da Silva, et al., 2021).

In addition, the interaction between the gut microbiota and B. coli infection has not been extensively studied in how it can modulate the host's response to infection. More studies on how the gut microbiota can influence susceptibility and disease severity during balantidiasis may point towards novel therapeutic approaches. Balantidiasis has been associated primarily with poor hygiene and sanitation conditions and particularly in regions where pigs are housing. The parasite is transmitted through the fecal-oral route; thus, most of the infection is associated with waterborne and foodborne transmissions. Epidemiological studies have shown that people in high-risk areas of pig farming and agriculture have higher infection rates than the general population. The absence of efficient surveillance in diagnosing balantidiasis restricts knowledge regarding its actual prevalence; thus, more accurate diagnostics are urgently needed.

The epidemiological landscape that relates to infectious diseases can be useful in understanding Balantidiasis. For example, a meta-analysis of global prevalence of chronic kidney disease revealed large variations that can exist in different demographical as well as geographical locations and regions of the world, thereby implicating socio-economic factors and healthcare access in the disease vulnerability. This echoes the share of mental health disorders among children and adolescents that indicates an interest in

underlying social determinants that might also house the transmission and management of parasitic infections like Balantidiasis (Khan et al., 2013).

The methodological challenges outlined in systematic reviews of prevalence studies are therefore pertinent to Balantidiasis research. The development of uniform methodologies in the assessment of prevalence and incidence rates of parasitic infections will be prerequisite towards meaningful comparisons of data as well as allocation of resources. Equally important is to critically assess bias risks in prevalence studies to ensure that findings adequately reflect the epidemiological picture (Hoy et al., 2012).

Finally, more studies of the socio-economic and environmental factors influencing the disease's distribution in endemic regions are desperately needed; such information could be used to design proper public health interventions that should be directed toward breaking the transmission cycle and the promotion of hygienic practices.

PATHOPHYSIOLOGY

The pathophysiology of balantidiasis results from complex interactions between host immune responses and parasitic mechanisms utilized by B. coli. In initial infections, the disease is acquired through the ingestion of viable cysts in food or water contaminated by carriers. Once in the intestines, the cysts excyst and trophozoites are released. These invade the mucosal lining of the colon and give rise to inflammation and ulceration. Invasion denotes an active and vigorous inflammatory response, essential for the presentation of clinical disease. It may also infect mucosal lung lining.

It has been highlighted in research that the immune response of the host greatly influences the severity of balantidiasis. The cytokine/chemokine response induced due to the trophozoites invasion initiation of an inflammatory cascade also imbalances tissue integrity leading to damage. Pro-inflammatory and anti-inflammatory mediator balance is needed whereby too much inflammation can lead to more tissue injury while too little facilitates parasite survival (Al-Qahtani, et al., 2024).

B. coli employs several mechanisms to increase its pathogenicity. The ability of the organism to adhere to intestinal epithelial cells is most important in its colonization and subsequent invasion. Adhesive properties are mediated by surface structures that bind to the colonic mucosa Adherence to the host cell is an initial step in the infection process since any pathogen must adhere to the host before establishing an infection. Additionally, it operates immune evasion strategies that complicate the development of effective immunological responses .

Balantidiasis can, therefore, clinically manifest with signs of severe dysentery with diarrhea, abdominal pain, and weight loss. The particular severity of the disease most often bears a direct relationship with the extent of mucosal invasion and the immune status of the host. Hence, clinically balantidiasis may present with symptoms from mild diarrhea to a picture of dysentery. Severity of symptoms is correlated with the immune status of the host and the parasite load. The disease can cause severe problems in immunocompromised individuals, for example HIV/AIDS infected individuals, which emphasizes the need for disease-specific treatment strategies (Bellanger et al., 2013).

Ponce-Gordo et al. (2011) research unveiled genetic heterogeneity in the rDNA ITS genes among B. coli. Discovery of significant variation within genetic composition among strains of B. coli indicates a complex evolutionary background. Implications of such genetic diversity could be enormous since it might impact the pathogenic potential as well as transmission dynamics of the parasite. Knowledge about genetic variation could help in planned therapeutics and control. The pathogenicity of B. coli is not clearly defined yet, but different mechanisms are believed to be involved. These mechanisms include adhesion to the intestinal epithelium and invasion of tissues .

Although there is an abundance of literature on E. coli pathogenesis, similar comprehensive studies on B. coli are sparse. Interaction with the host cell, especially concerning virulence factors, needs more insight into the pathogenic mechanisms of this organism. B. coli has lately become an important zoonosis due to the increasing connection between humans and pigs. There is a need for investigation on parasite transmission routes, especially from the animal reservoir to humans (Ahmed et al, 2020). Little information is currently available on the epidemiology of human infection by B. coli, and that of animal carriers, being a significant knowledge gap. More research can be directed towards prevalence studies on B. coli in different animal populations and their role in transmitting infections to humans.

MANAGEMENT

The conventional approach to the treatment of balantidiasis is through the use of antibiotics. Historically, tetracycline has been considered as the first choice of treatment due to its having proved to be significantly active against B. coli. A study has proven that the symptoms can resolve, and the level of the parasite load decreases after a course of tetracycline. However, the rise of antibiotic resistance challenges the issue and calls for other therapeutic avenues and approaches (Yazar et al., 2004). Another frequently used antibiotic is metronidazole which is used in combination formulations to enhance efficacy of the treatment. Studies have reported in many cases the successful reduction of symptoms and parasite eradication following treatment with metronidazole. Hazarika et al. (2016) However, due to the not unfavorable reactions of metronidazole and varying responses of different strains of B. coli towards metronidazole, further research should be carried out on the factors that could determine individual outcomes of treatment.

Moreover, some recent studies have shown, perhaps, combination therapies of treatment to be effective. Hankinson et al. (1999) reported efficacy in therapy when metronidazole was co-administered with tetracycline or iodoquinol. Sharma and Harding (2003) later developed combinations that might work better in delivering the desired goal against the parasite, that is, its synergistic effect towards more effective targeting of the pathogen, and in possibly reducing the period of treatment. However, such optimal combinations and mechanisms remain under-researched, which indicates a huge knowledge gap. Perhaps, directed therapies have the promise to usher in a new era in the treatment paradigm for protozoan infection. For example, genome editing technologies plus small molecule development targeting explicit pathways may mean fresh approaches to B. coli infections. Although a number of these strategies have been primarily studied in cancer therapy, there is much to be learned from the potential application of the lessons derived from those studies (Zhao et al., 1500).

Results of the study indicate that public health interventions are necessary to manage infectious diseases through infection control. A systematic review by Ayouni et al. (2021) listed effective public health actions that could save the situation regarding disease propagation most of which consist of hygiene practices, community mobilization, and sensitization in disease outbreaks. This finding was supported by O'Mara-Eves et al. (2015) from their scoping study that community engagement enhances the effectiveness of public health interventions, especially for disadvantaged groups. Community participation in health education would enhance disease awareness on Balantidium infection and drive the practice for prevention.

Furthermore, the study by Storr et al. (2017) identified the essential core components of effective programs for infection prevention and control that can be realigned to Balantidium. Among other recommendations are improved sanitation practices, hand hygiene promotion, and solid waste management to minimize the chances of transmission of B. coli.

Behavioral science theories are pertinent to public health intervention planning. The current insight, in addition, makes the knowledge of health behavioral determinants and, therefore, the strategy of infection control more effective. One, for example, of the Health Belief Model can be an implementation that overcomes the barriers involved in the false perception of the mode of transmission of B. coli or inadequacy in having an access to a place where one can wash his or her hands after visiting the restroom among others. Behavioral theories would therefore have informed the design of an effective hygiene practice campaign as indicated by Pan et al. (2020) in the analysis of public health interventions during the COVID-19 outbreak. Lessons from the pandemic can model good community practices for addressing other infectious diseases such as Balantidium infection.

CONCLUSION

In conclusion, balantidiasis unveils an intricate interplay between the pathogenic mechanisms of B. coli and the immune response of the host. There have been pronounced advances in understanding its pathophysiology, but research should be driven to fill in the existing gaps. Highlighting the molecular interactions of the gut microbiota and socio-economic factors driving transmission will enable future research to bring forward more effective prevention and treatment strategies against balantidiasis. The management and epidemiology of Balantidiasis need an integrated approach from other related disciplines to offer insight into various aspects that are in need of urgent attention for combating the neglected tropical disease. Factors that may improve our understanding of how adequately to fill the gaps and improve management for Balantidiasis to protect those vulnerable populations better.

REFERENCES:

1) Ahmed, A., Ijaz, M., Ayyub, R.M., Ghaffar, A., Ghauri, H.N., Aziz, M.U., Ali, S., Altaf, M., Awais, M., Naveed, M., Nawab, Y., Javed, M.U., (2020). Balantidium coli in domestic animals: An emerging protozoan pathogen of zoonotic significance. Acta Trop. 203, 105298. https://doi.org/10.1016/j.actatropica.2019.105298
2) Al-Qahtani, A. A., Alhamlan, F. S., & Al-Qahtani, A. A. (2024). Pro-Inflammatory and Anti-Inflammatory Interleukins in Infectious Diseases: A Comprehensive Review. *Tropical medicine and infectious disease*, *9*(1), 13. https://doi.org/10.3390/tropicalmed9010013
3) Al-tayib, O.A., 2014. Lung infection and severe anemia secondary to Balantidiasis in hamadryas baboons: A case report. Sch. Acad. J. Biosci. 2, 393–397.
4) Ayouni, Imen., Maatoug, J.., Dhouib, W.., Zammit, N.., Fredj, S.., Ghammam, Rim., & Ghannem, H.. (2021). Effective public health measures to mitigate the spread of COVID-19: a systematic review. BMC Public Health , 21 . http://doi.org/10.1186/s12889-021-11111-1
5) Ayouni, Imen., Maatoug, J.., Dhouib, W.., Zammit, N.., Fredj, S.., Ghammam, Rim., & Ghannem, H.. (2021). Effective public health measures to mitigate the spread of COVID-19: a systematic review. BMC Public Health , 21 . http://doi.org/10.1186/s12889-021-11111-1
6) Ayouni, Imen., Maatoug, J.., Dhouib, W.., Zammit, N.., Fredj, S.., Ghammam, Rim., & Ghannem, H.. (2021). Effective public health measures to mitigate the spread of COVID-19: a systematic review. BMC Public Health , 21 . http://doi.org/10.1186/s12889-021-11111-1

7) Ayouni, Imen., Maatoug, J.., Dhouib, W.., Zammit, N.., Fredj, S.., Ghammam, Rim., & Ghannem, H.. (2021). Effective public health measures to mitigate the spread of COVID-19: a systematic review. BMC Public Health , 21 . http://doi.org/10.1186/s12889-021-11111-1
8) Bellanger, A.-P., Scherer, E., Cazorla, A., Grenouillet, F., (2013). Dysenteric syndrome due to Balantidium coli: a case report. New Microbiol. 36, 203–205.
9) da Silva, R. K. M., Dib, L. V., Amendoeira, M. R., Class, C. C., Pinheiro, J. L., Fonseca, A. B. M., & Barbosa, A. D. S. (2021). Balantidiasis in humans: A systematic review and meta-analysis. *Acta tropica*, *223*, 106069. https://doi.org/10.1016/j.actatropica.2021.106069
10) Flores-Mireles, A.., Walker, Jennifer N.., Caparon, M.., & Hultgren, S.. (2015). Urinary tract infections: epidemiology, mechanisms of infection and treatment options. *Nature Reviews Microbiology* , 13 , 269-284. http://doi.org/10.1038/nrmicro3432
11) Hankinson, S. J., Wakelin, D., & Nakauchi, M. (1999). *Balantidium coli: Description, lifecycle, and management*. Infections in laboratory animals and their implications for research. Veterinary Parasitology, 85(2), 125–134. doi:10.1016/S0304-4017(98)00299-3
12) Hazarika, M., Pai H, V., Khanna, V., Reddy, H., Tilak, K., & Chawla, K. (2016). Rare Case of Polymicrobial Keratitis with Balantidium coli. *Cornea*, *35*(12), 1665–1667. https://doi.org/10.1097/ICO.0000000000000982
13) Khan, A., Khan, M.S., Avais, M., Ijaz, M., Ali, M.M., Abbas, T., (2013). Prevalence, hematology, and treatment of balantidiasis among donkeys in and around Lahore, Pakistan. Vet. Parasitol. 196, 203–205. https://doi.org/10.1016/j.vetpar.2013.01.017
14) O'Mara-Eves, A.., Brunton, G.., Oliver, S.., Kavanagh, J.., Jamal, F.., & Thomas, James. (2015). The effectiveness of community engagement in public health interventions for disadvantaged groups: a meta-analysis. BMC Public Health , 15. http://doi.org/10.1186/s12889-015-1352-y
15) Ponce-Gordo, F., & García-Rodríguez, J. J. (2021). Balantioides coli. *Research in veterinary science*, *135*, 424–431. https://doi.org/10.1016/j.rvsc.2020.10.028'
16) Ponce-Gordo, F.., Fonseca-Salamanca, F.., & Martínez-Díaz, R.. (2011). Genetic heterogeneity in internal transcribed spacer genes of Balantidium coli (Litostomatea, Ciliophora).. Protist, 162 5, 774-94 . http://doi.org/10.1016/j.protis.2011.06.008
17) Sharma, S., & Harding, G. (2003). Necrotizing lung infection caused by the protozoan Balantidium coli. *The Canadian journal of infectious diseases = Journal canadien des maladies infectieuses*, *14*(3), 163–166. https://doi.org/10.1155/2003/829860
18) Yazar, S., Altuntas, F., Sahin, I., & Atambay, M. (2004). Dysentery caused by Balantidium coli in a patient with non-Hodgkin's lymphoma from Turkey. *World journal of gastroenterology*, *10*(3), 458–459. https://doi.org/10.3748/wjg.v10.i3.458
19) Zhao, W., Xiong, J., Li, M., Bu, X., Jiang, C., Wang, G., Zhang, J., Zou, H., Miao, W., Chen, K., & Wang, G. (2024). Genome assembly of a symbiotic balantidia (*Balantidium ctenopharyngodoni*) in fish hindgut. *Scientific Data*, *11*(323). https://doi.org/10.1038/s41597-024-03142-1