Juniper Publishers
key to the Researchers

Advances in
Biotechnology & Microbiology

Review Article
Volume 1 Issue 2 - June 2016

Adv Biotech & Micro

Role of Cytokines during Influenza Infection- What we need to Know?

Sheetal Verma[1]*, Nivedita Tiwari[2] and Dhole TN[2]

[1]*Department of Microbiology, King George's Medical University, India*

[2]*Department of Microbiology, Sanjay Gandhi Post Graduate Institute of Medical Sciences, India*

Submission: May 27, 2016; **Published:** June 08, 2016

***Corresponding author:** Sheetal Verma, Assistant Professor, Department of Microbiology, King George's Medical University, Shah Mina Road, Chowk, Lucknow- 226003, Uttar Pradesh, India, Tel: 9936269516; Email: dr.sheetal2001@gmail.com

Abstract

The primary target of influenza virus infection is the airway epithelial cells lining the respiratory mucosa but also infect alveolar macrophages and dendritic cells (DCs) that reside in the airways. In vitro as well as in vivo studies suggest that pro-inflammatory cytokines such as IL-1, TNF-α and IFN-β are secreted by infected cells and immune cells to sustain inflammatory response as well as induction of the chemokines (i.e. MCP-1, interferon-gamma (IFN-γ) which attract mononuclear leukocytes that occurs within two days of an influenza virus infection but most chemokines favour neutrophils.

Keywords: Inflammation; Influenza; Interleukins

Introduction

IL-6 is a multifunctional cytokine that can regulate immune and inflammatory responses involved in the activation, growth and differentiation of T-cells [1] and can contribute to T cell mediated inflammatory reactions. In fact, autopsy examination showed an increased CD3+ T cells in the interstitium of the lung from patients with H5N1 diseases [2]. In addition, IL-6 has been shown to be released by macrophages and epithelial cells during lung injury [3] and the effects of IL-6 are synergistic with those of IL-1 and TNF-α [4].

IL-8 is believed to play a role in the pathogenesis of bronchiolitis, a common respiratory tract disease caused by viral infection. This proinflammatory cytokine regulates the proinflammatory response in Influenza virus infection [5]. There are reports stating the activation of MAPK pathway induces production of proinflammatory cytokine such as IL-8 [6,7] in response to influenza virus infection. Interleukin 8 (IL-8) is a chemokine produced by macrophages and other cell types such as epithelial cells, airway smooth muscle cells [8] and endothelial cells. Endothelial cells store IL-8 in their storage vesicles, the Weibel-Palade bodies [9]. In humans, the interleukin-8 protein is encoded by the IL8 gene [10].

IL-8, also known as neutrophil chemo tactic factor, has two primary functions. It induces chemotaxis in target cells, primarily neutrophils but also other granulocytes, causing them to migrate toward the site of infection. IL-8 also induces phagocytosis once they have arrived. IL-8 is also known to be a potent promoter of angiogenesis. In target cells, IL-8 induces a series of physiological responses required for migration and phagocytosis, such as increases in intracellular Ca2+, exocytosis (e.g. histamine release), and the respiratory burst. Interleukin-10 (IL-10), also known as human cytokine synthesis inhibitory factor (CSIF), is an anti-inflammatory cytokine. In humans, IL-10 is encoded by the IL10 gene [11]. IL-10 is a cytokine with pleiotropic effects in immune regulation and inflammation. It down regulates the expression of Th1 cytokines, MHC class II antigens, and co-stimulatory molecules on macrophages. It also enhances B cell survival, proliferation, and antibody production. IL-10 can block NF-κB activity, and is involved in the regulation of the JAK-STAT signaling pathway. Thus over all the importance of IL-10 for counteracting the hyperactive immune response in the human body [12].

Discussion

TNF-α is a pleiotropic pro-inflammatory cytokine that exerts multiple biological effects, including those on the inflammatory

response and host resistance to pathogens. Macrophages and members of the monocyte lineage are thought to be the predominant cells that synthesize TNF-α thereby contributing the most to the local and systemic TNF-α responses *in vivo*, although other immune cells such as natural killer cells, T and B lymphocytes and Kupffer cells are also found to produce TNF-α [13]. During infection, TNF-α is an important acute phase cytokine that triggers the local immune response and containment of infection. It initiates a cascade of cytokines and increase vascular permeability that aids in the recruitment of macrophages, neutrophils and lymphocytes to the site of infection. Recent studies have suggested that TNF-α is known as one of the main mediators causing ARDS [14], [Figure 1&2].

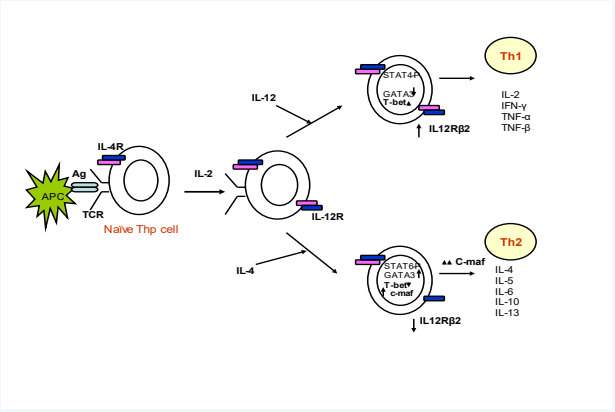

Figure 1: Diagrammatic representation of transcriptional regulation of T helper cell differentiation.

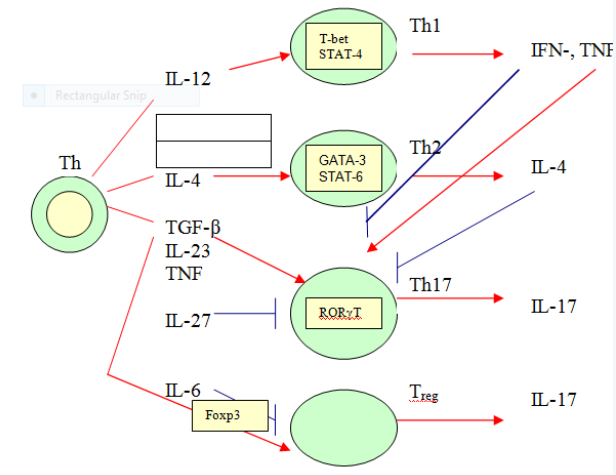

Figure 2: Differentiation and regulation of T-helper cells. Red arrow indicates up regulation; and blue lines indicate inhibition. Yellow boxes indicate nucleus of Th cells and within it transcription factors of particular lineage are mentioned.

Interferons (IFNs) constitute a class of cytokines with antiviral activities and were first identified as a substance to suppress viral replication [15]. IFN-β, a type I interferon, is essential to inhibit board range of virus replication. The downstream effect of interferons particular on IFN-β was extensively studied. The interferon protein binds to its specific cognate receptor on the surface of cells leading to activation of the signaling system known as the Jak/STAT pathway [16]. The antiviral effects of IFN-β are mediated through this pathway to trigger the expression of many anti-viral genes. H5N1 viruses were found to resist the antiviral effects of IFNs in pig epithelial cells [17]. Previous studies from our group have demonstrated that both H5N1 and H1N1 influenza viruses induced IFN-β responses in primary human alveolar and bronchial epithelial cells [18], and this may be relevant in disease pathogenesis.

MCP-1 is produced in response to inflammatory stimuli by a variety of cells, including monocytes/macrophages, lymphocytes and airway epithelial cells [19,20]. It was shown to be a major contributor to the robust arrest of monocytes to inflamed endothelium under shear stress conditions *in vitro* [21,22]. MCP-1 also stimulates collagen synthesis and production of the pro-fibrotic factor transforming growth factor β (TGF-β) in fibroblasts, while MCP-1 antisense oligonucleotides reduce TGF-β production [23]. Although MCP-1 was originally described for its chemo tactic activity on monocytes, *in vitro* studies revealed an even higher activity on T cells [24]. This occurs through MCP-1 binding to its sole receptor CCR2.

Conclusion

The studies focusing upon detailed mechanism of anti-inflammatory response to different virus strains including influenza are needed to be carried out. The issue also needs to describe why different strain of virus show different anti-inflammatory response and disease severity.

References

1. Van Snick J (1990) Interleukin-6: an overview. Annu Rev Immunol 8: 253-278.
2. Peiris JS, Yu WC, Leung CW, Cheung CY, Ng WF, et al. (2004) Re-emergence of fatal human influenza A subtype H5N1 disease. Lancet 363(9409): 617-619.
3. Hierholzer C, Kalff JC, Omert L, Tsukada K, Loeffert JE, et al. (1998) Interleukin-6 production in hemorrhagic shock is accompanied by neutrophil recruitment and lung injury. Am J Physiol 275(3 Pt 1): 611-621.
4. Le J, Reis LF, Vilcek J (1988) Tumor necrosis factor and interleukin 1 can act as essential growth factors in a murine plasmacytoma line. Lymphokine Res 7(2): 99-106.
5. Xing Z, Gao W, Li BQX, Jin Y, Yang K, et al. (2010) Regulation of proinflammatory cytokine Interleukin-6 (IL-6) induction by NF-kappa B signaling in pandemic H1N1 influenza A virus-infected human bronchial epithelial cells (45.29). The Journal of Immunology 184(1 Supplement): 45.29.
6. Li L, Chen SF, Liu Y (2009) MAP kinase phosphatase-1, a critical negative regulator of the innate immune response. Int J Clin Exp Med 2(1): 48-67.
7. Owens DM, Keyse SM (2007) Differential regulation of MAP kinase signalling by dual-specificity protein phosphatases. Oncogene 26(22): 3203-3213.

How to cite this article: Sheetal V, Nivedita T, Dhole T. Role of Cytokines during Influenza Infection- What we need to Know?. Adv Biotech & Micro. 2016; 1(2): 555556. DOI: 10.19080/AIBM.2016.01.555556

8. John M, Au BT, Jose PJ, Lim S, Saunders M, et al. (1998) Expression and Release of Interleukin-8 by Human Airway Smooth Muscle Cells: Inhibition by Th-2 Cytokines and Corticosteroids. Am J Respir Cell Mol Biol 18(1): 84-90.

9. Wit TR, Leeuw HP, Rondaij MG, Laaf RT, Sellink E, et al. (2003) Von Willebrand factor targets IL-8 to Weibel-Palade bodies in an endothelial cell line. Exp Cell Res 286(1): 67-74.

10. Mukaida N, Shiroo M, Matsushima K (1989) Genomic structure of the human monocyte-derived neutrophil chemotactic factor IL-8. J Immunol 143(4): 1366-1371.

11. Eskdale J, Kube D, Tesch H, Gallagher G (1997) Mapping of the human IL10 gene and further characterization of the 5' flanking sequence. Immunogenetics 46(2): 120-128.

12. Braat H, Rottiers P, Hommes DW, Huyghebaert N, Remaut E, et al. (2006) A phase I trial with transgenic bacteria expressing interleukin-10 in Crohn's disease. Clin Gastroenterol Hepatol 4(6): 754-759.

13. Wang Y, Lobigs M, Lee E, Mullbacher A (2003) CD8+ T cells mediate recovery and immunopathology in West Nile virus encephalitis. J Virol 77(24): 13323-13334.

14. Lee KS, Choi YH, Kim YS, Baik SH, Oh YJ, et al. (2008) Evaluation of bronchoalveolar lavage fluid from ARDS patients with regard to apoptosis. Respir Med 102(3): 464-469.

15. Samuel CE (2001) Antiviral actions of interferons. Clin Microbiol Rev 14(4): 778-809.

16. Darnell JE, Kerr IM, Stark GR (1994) Jak-STAT pathways and transcriptional activation in response to IFNs and other extracellular signaling proteins. Science 264(5164): 1415-1421.

17. Seo SH, Goloubeva O, Webby R, Webster RG (2001) Characterization of a porcine lung epithelial cell line suitable for influenza virus studies. J Virol 75(19): 9517-9525.

18. Chan MC, Cheung CY, Chui WH, Tsao SW, Nicholls JM, et al. (2005) Proinflammatory cytokine responses induced by influenza A (H5N1) viruses in primary human alveolar and bronchial epithelial cells. Respir Res 6: 135.

19. Yoshimura T, Yuhki N, Moore SK, Appella E, Lerman MI, et al. (1989) Human monocyte chemoattractant protein-1 (MCP-1). Full-length cDNA cloning, expression in mitogen-stimulated blood mononuclear leukocytes, and sequence similarity to mouse competence gene JE. FEBS Lett 244(2): 487-493.

20. Lundien MC, Mohammed KA, Nasreen N, Tepper RS, Hardwick JA, et al. (2002) Induction of MCP-1 expression in airway epithelial cells: role of CCR2 receptor in airway epithelial injury. J Clin Immunol 22(3): 144-152.

21. Gerszten RE, Garcia-Zepeda EA, Lim YC, Yoshida M, Ding HA, et al. (1999) MCP-1 and IL-8 trigger firm adhesion of monocytes to vascular endothelium under flow conditions. Nature 398(6729): 718-723.

22. Luscinskas FW, Gerszten RE, Garcia-Zepeda EA, Lim YC, Yoshida M, et al. (2000) C-C and C-X-C chemokines trigger firm adhesion of monocytes to vascular endothelium under flow conditions. Ann N Y Acad Sci 902: 288-293.

23. Hogaboam CM, Bone-Larson CL, Lipinski S, Lukacs NW, Chensue SW, et al. (1999) Differential monocyte chemoattractant protein-1 and chemokine receptor 2 expression by murine lung fibroblasts derived from Th1- and Th2-type pulmonary granuloma models. J Immunol 163(4): 2193-2201.

24. Carr I (1972) The fine structure of microfibrils and microtubules in macrophages and other lymphoreticular cells in relation to cytoplasmic movement. J Anat 112(3): 383-389.

How to cite this article: Sheetal V, Nivedita T, Dhole T. Role of Cytokines during Influenza Infection- What we need to Know?. Adv Biotech & Micro. 2016; 1(2): 555556. DOI: 10.19080/AIBM.2016.01.555556