Inducible Nitric Oxide Synthase (iNOS) and Obstruction Research Literatures

Ma Hongbao [1], Margaret Ma [2], Yang Yan [1]

[1] Brookdale Hospital, Brooklyn, New York 11212, USA; [2] Cambridge, MA 02138, USA
ma8080@gmail.com

Abstract: Nitric oxide synthases (NOSs, EC 1.14.13.39) are a family of enzymes catalyzing the production of nitric oxide (NO) from L-arginine. NO is an important cellular signaling molecule that helps to modulate the vascular tone, insulin secretion, airway tone and peristalsis, etc, and NO is involved in angiogenesis and neural development. It may function as a retrograde neurotransmitter. NO is mediated in mammals by the calcium-calmodulin controlled isoenzymes eNOS (endothelial NOS) and nNOS (neuronal NOS). The inducible isoform, iNOS, is involved in immune response, binds calmodulin at physiologically relevant concentrations, and produces NO as an immune defense mechanism, as NO is a free radical with an unpaired electron. It is the proximate cause of septic shock and may function in autoimmune disease. Obstructive uropathy is a condition in which the flow of urine is blocked. This causes the urine to back up and injure one or both kidneys. Obstructive uropathy occurs when urine cannot drain through a ureter. Urine backs up into the kidney and causes it to become hydronephrosis. It can occur suddenly, or be a long-term problem. If the blockage comes on suddenly, kidney damage is less likely if the problem is detected and treated promptly, and the damage to the kidneys goes away normally. Long-term damage to the kidneys may occur if the blockage has been present for a long time. If the problem is caused by a blockage in the bladder, the bladder may have long-term damage, which may lead to problems emptying the bladder or leakage of urine. This article introduces recent research reports as references in the inducible nitric oxide Synthase (iNOS) and obstruction related studies.

[Ma H, Young M, Yang Y. **Inducible Nitric Oxide Synthase (iNOS) and Obstruction Research Literatures.** *Academ Arena* 2015;7(6):97-102]. (ISSN 1553-992X). http://www.sciencepub.net/academia. 12

Key words: inducible nitric oxide synthase (iNOS); Obstruction; life; cell

1. Introduction

Nitric oxide synthases (NOSs, EC 1.14.13.39) are a family of enzymes catalyzing the production of nitric oxide (NO) from L-arginine. NO is an important cellular signaling molecule that helps to modulate the vascular tone, insulin secretion, airway tone and peristalsis, etc, and NO is involved in angiogenesis and neural development. It may function as a retrograde neurotransmitter. NO is mediated in mammals by the calcium-calmodulin controlled isoenzymes eNOS (endothelial NOS) and nNOS (neuronal NOS). The inducible isoform, iNOS, is involved in immune response, binds calmodulin at physiologically relevant concentrations, and produces NO as an immune defense mechanism, as NO is a free radical with an unpaired electron. It is the proximate cause of septic shock and may function in autoimmune disease.

Obstructive uropathy is a condition in which the flow of urine is blocked. This causes the urine to back up and injure one or both kidneys. Obstructive uropathy occurs when urine cannot drain through a ureter. Urine backs up into the kidney and causes it to become hydronephrosis. It can occur suddenly, or be a long-term problem. If the blockage comes on suddenly, kidney damage is less likely if the problem is detected and treated promptly, and the damage to the kidneys goes away normally. Long-term damage to the kidneys may occur if the blockage has been present for a long time. If the problem is caused by a blockage in the bladder, the bladder may have long-term damage, which may lead to problems emptying the bladder or leakage of urine. This article introduces recent research reports as references in the related studies

The following introduces recent reports as references in the related studies.

Arriero, M. M., A. Lopez-Farre, et al. "Expression of inducible nitric oxide synthase in the liver of bile duct-ligated Wistar rats with modulation by lymphomononuclear cells." Surgery. 2001 Mar;129(3):255-66.

BACKGROUND: The current study evaluated whether biliary tract obstruction stimulates inducible nitric oxide synthase (iNOS) protein expression in the liver and analyzed the implication of lymphomononuclear cells and interleukin-4 (IL-4). METHODS: Male Wistar rats were used. Bile flow interruption was achieved by a complete division of the extrapancreatic common bile duct. iNOS expression was determined by both the Western blot technique and immunohistochemistry. RESULTS: iNOS protein was markedly expressed in the liver 7 days after bile duct obstruction. Treatment with

thymostimulin (TP-1), a partially purified thymic extract, reduced the intensity of the expression of iNOS protein in the liver after bile duct ligation. Recent data have suggested that IL-4 attenuates iNOS protein expression. We then analyzed the involvement of this anti-inflammatory cytokine on the modulation of iNOS expression in the liver. The liver from rats that underwent bile duct ligation (BDL) showed a lower content of IL-4 than that of sham-operated (SO) rats. TP-1 treatment increased the content of IL-4 in the liver. Liver slices incubated in vitro with Escherichia coli lipopolysaccharide (LPS, 10 microg/mL) stimulated the expression of iNOS protein. The level of LPS-induced iNOS expression was reduced by lymphomononuclear cells obtained from sham-operated animals. However, lymphomononuclear cells isolated from BDL rats potentiated the induction of iNOS expression by LPS-stimulated liver. However, lymphomononuclear cells from TP-1-treated BDL rats failed to modify LPS-stimulated iNOS expression. The different effect of lymphomononuclear cells on the modulation of iNOS expression in the liver was associated with their ability to generate IL-4. CONCLUSIONS: The liver of jaundiced rats markedly expressed iNOS protein, which was associated to modifications in the content of IL-4 in the liver. Furthermore, lymphomononuclear cells modulate iNOS protein expression in the liver by a mechanism in which IL-4 is involved.

Bonvissuto, G., L. Minutoli, et al. "Effect of Serenoa repens, lycopene, and selenium on proinflammatory phenotype activation: an in vitro and in vivo comparison study." Urology. 2011 Jan;77(1):248.e9-16. doi: 10.1016/j.urology.2010.07.514. Epub 2010 Dec 15.

OBJECTIVES: To investigate the antiinflammatory activity of Serenoa repens (SeR), LY, and) on proinflammatory phenotype in rat peritoneal macrophages (Ms) stimulated with Salmonella enteritidis lipopolysaccharide (LPS) and in the prostate of rats with partial bladder outlet obstruction. SeR, combined with other compounds, such as LY and Se is used to relieve symptoms associated with benign prostatic hyperplasia (BPH). Inflammation plays a pivotal role in the pathogenesis of BPH and represents a target for anti-BPH drugs. METHODS: After stimulation with 1 mug/mL of LPS, peritoneal rat MPhis were coincubated with LY (2 mug/mL), Se (0.03 mug/mL), and SeR (10 mug/mL), alone or in association (LY-Se-SeR) and with RPMI. Inducible cyclooxygenase (COX-2), 5-lypoxygenase (5-LOX), inducible nitric oxide synthase (iNOS), and inhibitor kappaBalpha (IkappaB-alpha) protein were evaluated by Western blot. Nuclear factor-kappa B (NF-kappaB) binding activity was measured by electrophoretic mobility shift assay. Tumor necrosis factor-alpha (TNF-alpha) gene expression was investigated by real-time polymerase chain reaction. We also evaluated malondialdehyde (MDA) and nitrite levels. RESULTS: LPS stimulation produced a proinflammatory phenotype in rat peritoneal MPhis. LY, Se, and SeR inhibited the inflammatory cascade, but the Ly-Se-SeR association caused a greater inhibitory effect on the expression of COX-2, 5-LOX, and iNOS. The Ly-Se-SeR association showed a higher efficacy in reducing the loss of IkappaB-alpha, the increased NF-kappaB binding activity, the enhanced mRNA levels of TNF-alpha, the elevated MDA, and nitrite content. The LY-Se-SeR association in vivo caused a greater inhibitory effect on prostate inflammation induced in rats by partial bladder outlet obstruction. CONCLUSIONS: The LY-Se-SeR association might be useful in the treatment of BPH.

De Winter, B. Y., A. J. Bredenoord, et al. "Effect of inhibition of inducible nitric oxide synthase and guanylyl cyclase on endotoxin-induced delay in gastric emptying and intestinal transit in mice." Shock. 2002 Aug;18(2):125-31.

Nitric oxide (NO) is postulated to play a role in endotoxin-induced ileus. We investigated the effect of selective blockade of inducible NO synthase (iNOS) and guanylyl cyclase on endotoxin-induced ileus in mice. Thirty minutes before injection of lipopolysaccharides (LPS), mice were pretreated with L-NAME (N omega-nitro-L-arginine methyl ester, non-selective NOS inhibitor), 1400W (N-(3-(aminomethyl)benzyl)acetamide, selective iNOS inhibitor), ODQ (1H-(1,2,4)oxadiazolo(4,3-a)quinoxalin-1-one, guanylyl cyclase inhibitor), dimethyl sulfoxide (DMSO, vehicle), or dexamethasone. After 18 h, general well being deteriorated and the mice developed hypothermia and a significant delay in gastric emptying and intestinal transit as measured by Evans blue. 1400W completely reversed the endotoxin-induced delay in gastric emptying, while L-NAME did not have these beneficial effects. On the contrary, even in control mice, L-NAME delayed gastric emptying. Dexamethasone, DMSO, and ODQ mimicked the effect of 1400W on endotoxin-induced delay in gastric emptying. The endotoxin-induced delay in transit was significantly improved only by 1400W. None of the drugs reversed the hypothermia. In LPS mice treated with L-NAME, the behavior scale increased even further, while it decreased after treatment with 1400W. In conclusion, selective inhibition of iNOS reverses the endotoxin-induced delay in gastric emptying and transit and improves general well being. The pathway used by NO, derived from iNOS, may

involve inhibition of guanylyl cyclase or radical scavenging.

Hess, A., W. Bloch, et al. "In vitro expression of inducible nitric oxide synthase in the nasal mucosa of guinea pigs after incubation with lipopolysaccharides or cytokines." Eur Arch Otorhinolaryngol. 1998;255(9):448-53.

In order to demonstrate the involvement of nitric oxide synthases (NOS)--in particular the inducible isoform (iNOS)--in inflammatory processes within the nasal airways, we used organ-bath incubation to study isolated inferior turbinates and mucosa of the maxillary sinus of guinea pigs. The pattern of the expression in various substructures of the nasal mucosa was of special interest. Mucosa was incubated for 6 h with lipopolysaccharides (LPS) produced by E. coli, interleukin II (IL-2) or tumor necrosis factor-alpha (TNF-alpha). Saline was used as the control solution. Following incubation the specimens were fixed in buffered 4% formaldehyde solution over a period of 4 h. Tissues were next exposed to nicotinamide adenine dinucleotide phosphate (NADPH)-diaphorase-reaction and immunostained with specific antibodies to iNOS. Results then showed a clearly increased or initiated expression of iNOS in epithelium, glands, leucocytes and blood vessels of treated tissues in comparison to the control specimens. The inflammatory mediator LPS and the cytokines Il-2 or TNF-alpha alone were found to be capable of increasing the expression of iNOS, although the effects of LPS clearly exceeded those of the cytokines. This finding implicates iNOS-generated nitric oxide as a key factor for causing nasal swelling, secretion and obstruction during nasal infections and allergic episodes.

Hess, A., W. Bloch, et al. "[Detection of nitric oxide synthases in physiological and pathophysiological processes of the nasal mucosa]." HNO. 2000 Jul;48(7):489-95.

Nitric oxide (NO) can play an important role in the regulation of vascular tone and neurotransmission, as well as in non-specific immunoreactions and inflammation in a variety of tissues. Increased quantities of nitric oxide in respired air can be measured during inflammatory processes. However, the exact role and precise sources of NO under physiological and pathophysiological conditions within the airways remain to be defined. Three isoforms of NO-synthases can be distinguished: two constitutive (neuronal and endothelial) Ca(2+)-dependent cNOS and one inducible Ca(2+)-independent iNOS (NOS II). Constitutive NOS (NOS I and III) release a basal amount of NO under physiological conditions. The inducible form once expressed can catalyse the generation of large quantities of NO. Many kinds of cells, such as macrophages, neutrophils, endothelium and smooth muscle cells, are capable of expressing NOS II. Since all isoforms of NO-synthase seem to be present in nasal tissues and the expression of iNOS under inflammatory conditions seems to be responsible for excessive production of NO, the distribution of NOS-isoforms (especially NOS II) in normal and inflammatory nasal tissue, as well as the exact requirements for expression of iNOS remain to be proven. Non-inflamed fresh human nasal mucosa from the middle turbinate was compared immuno-histologically with nasal mucosa having the typical findings of chronic polypoid rhinosinusitis (i.e., polypoid middle turbinates and polyps of the middle nasal duct). In order to gain more information about the mechanisms of acute inflammation, non-inflamed vital turbinates were incubated in vitro with the proinflammatory substances bacterial lipopolysaccharides (LPS) and tumor necrosis-factor (TNF) for 30, 60, 90, 120, 180 and 240 min. Subsequent to exposure to NADPH-diaphorase and immunostaining with specific antibodies to each NOS-isoform, clearly increased or initiated expressions of inducible NOS (iNOS) in blood vessels, glands, macrophages and epithelium of chronically inflamed and LPS-incubated nasal tissue became apparent in comparison to the non-inflamed controls. In contrast, NOS III/NOS I seemed to be not affected. The onset of immunohistochemically recognizable NOS II expression was observed after 90 min incubation with of LPS/TNF-alpha. Polypoid tissue showed a strong increase in submucosal thickness and a high infiltration of iNOS-positive leukocytes (granulocytes and macrophages) compared to the LPS-incubated non-inflamed specimens. These findings implicate NOS II generated nitric oxide as a key agent for causing swelling, secretion and obstruction in patients with acute and chronic polypoid or allergic rhinitis. These findings also suggest that molecular NO has to be considered in the pathophysiology of chronic polypoid rhinosinusitis.

Keller, A. C., D. Rodriguez, et al. "Nitric oxide paradox in asthma." Mem Inst Oswaldo Cruz. 2005 Mar;100 Suppl 1:19-23. Epub 2005 Jun 14.

Asthma results from allergen-driven intrapulmonary Th2 response, and is characterized by intermittent airway obstruction, airway hyperreactivity (AHR), and airway inflammation. Accumulating evidence indicates that inflammatory diseases of the respiratory tract are commonly associated with elevated production of nitric oxide (NO). It has been shown that exhaled NO may be derived from constitutive NO synthase (NOS) such as endothelial

(NOS 3) and neural (NOS 1) in normal airways, while increased levels of NO in asthma appear to be derived from inducible NOS2 expressed in the inflamed airways. Nevertheless, the functional role of NO and NOS isoforms in the regulation of AHR and airway inflammation in human or experimental models of asthma is still highly controversial. In the present commentary we will discuss the role of lipopolysaccharides contamination of allergens as key element in the controversy related to the regulation of NOS2 activity in experimental asthma.

Rengasamy, A., C. Kommineni, et al. "Effects of hard metal on nitric oxide pathways and airway reactivity to methacholine in rat lungs." Toxicol Appl Pharmacol. 1999 Jun 15;157(3):178-91.

To examine whether the development of hard metal (HM)-induced occupational asthma and interstitial lung disease involves alterations in nitric oxide (NO) pathways, we examined the effects of an industrial HM mixture on NO production, interactions between HM and lipopolysaccharide (LPS) on NO pathways, and alterations in airway reactivity to methacholine in rat lungs. HM (2.5 to 5 mg/100 g intratracheal) increased NO synthase (NOS; EC 1.14.23) activity of rat lungs at 24 h without increasing inducible NOS (iNOS) or endothelial NOS (eNOS) mRNA abundance or iNOS, eNOS, or brain NOS (bNOS) proteins. The increase in NOS activity correlated with the appearance histologically of nitrotyrosine immunofluorescence in polymorphonuclear leukocytes (PMN) and macrophages. Intraperitoneal injection of LPS (1 mg/kg) caused up-regulation of iNOS activity, mRNA, and protein at 8 h but not at 24 h. HM at 2.5 mg/100 g, but not at 5 mg/100 g, potentiated the LPS-induced increase in NOS activity, iNOS mRNA, and protein. However, HM decreased eNOS activity at 8 h and eNOS protein at 24 h. Whole body plethysmography on conscious animals revealed that HM caused basal airway obstruction and a marked hyporeactivity to inhaled methacholine by 6-8 h, which intensified over 30-32 h. HM-treatment caused protein leakage into the alveolar space, and edema, fibrin formation, and an increase in the number of inflammatory cells in the lungs and in the bronchoalveolar lavage. These results suggest that a HM-induced increase in NO production by pulmonary inflammatory cells is associated with pulmonary airflow abnormalities in rat lungs.

Rodriguez, D., A. C. Keller, et al. "Bacterial lipopolysaccharide signaling through Toll-like receptor 4 suppresses asthma-like responses via nitric oxide synthase 2 activity." J Immunol. 2003 Jul 15;171(2):1001-8.

Asthma results from an intrapulmonary allergen-driven Th2 response and is characterized by intermittent airway obstruction, airway hyperreactivity, and airway inflammation. An inverse association between allergic asthma and microbial infections has been observed. Microbial infections could prevent allergic responses by inducing the secretion of the type 1 cytokines, IL-12 and IFN-gamma. In this study, we examined whether administration of bacterial LPS, a prototypic bacterial product that activates innate immune cells via the Toll-like receptor 4 (TLR4) could suppress early and late allergic responses in a murine model of asthma. We report that LPS administration suppresses the IgE-mediated and mast cell-dependent passive cutaneous anaphylaxis, pulmonary inflammation, airway eosinophilia, mucus production, and airway hyperactivity. The suppression of asthma-like responses was not due to Th1 shift as it persisted in IL-12(-/-) or IFN-gamma(-/-) mice. However, the suppressive effect of LPS was not observed in TLR4- or NO synthase 2-deficient mice. Our findings demonstrate, for the first time, that LPS suppresses Th2 responses in vivo via the TLR4-dependent pathway that triggers NO synthase 2 activity.

Schwarz, N. T., B. Engel, et al. "Lipopolysaccharide preconditioning and cross-tolerance: the induction of protective mechanisms for rat intestinal ileus." Gastroenterology. 2002 Aug;123(2):586-98.

BACKGROUND & AIMS: Endotoxin elicits an inflammatory response within the intestinal muscularis and causes intestinal muscle dysfunction. Our aims were to investigate intestinal muscle recovery after a single or repeated lipopolysaccharide (LPS) injections. We also investigated the ability of LPS to induce cross-tolerance to postoperative ileus. METHODS: Motility was measured in vivo and in vitro by transit and organ-bath techniques. Nuclear factor kappa-B, nuclear factor interleukin 6, and signal transducer and activator of transcription were quantified by using electrophoretic mobility shift assay, and tumor necrosis factor alpha, interleukin 6, inducible nitric oxide synthase, and cyclooxygenase 2 were measured with reverse-transcription polymerase chain reaction. Myeloperoxidase histochemistry for neutrophils was performed in jejunal muscularis whole mounts. RESULTS: Endotoxin-induced suppression of in vitro muscle contractility temporally recovered over 7 days with a similar profile whether after a single dose or during the continuous daily injection of LPS. Functional adaptation to continuous LPS was reflected in a significant blunting of transcription factor activation and cytokine messenger RNA up-regulation compared with the naive LPS-stimulated muscularis. Preconditioning of the

muscularis showed significant cross-tolerance to the functional, molecular, and leukocytic sequelae of intestinal manipulation. CONCLUSIONS: The muscularis externa recovered and developed tolerance to endotoxin over 7 days, which conferred cross-tolerance to intestinal manipulation. Thus, preconditioning induces protective mechanisms to a subsequent insult within the muscularis externa.

Wang, Z. K., J. G. Xiao, et al. "Effect of biliary drainage on inducible nitric oxide synthase, CD14 and TGR5 expression in obstructive jaundice rats." World J Gastroenterol. 2013 Apr 21;19(15):2319-30. doi: 10.3748/wjg.v19.i15.2319.

AIM: To investigate the effect of biliary drainage on inducible nitric oxide synthase (iNOS), CD14 and TGR5 expression in rats with obstructive jaundice (OJ). METHODS: Male adult Sprague-Dawley rats were randomly assigned to four groups: OJ, sham operation (SH), internal biliary drainage (ID) and external biliary drainage (ED). Rat models were successfully established by two operations and succumbed for extraction of Kupffer cells (KCs) and liver tissue collection on the 8(th) and 15(th) day. KCs were isolated by in situ hepatic perfusion and digested with collagen IV, density gradient centrifuged by percoll reagent and purified by cell culture attachment. The isolated KCs were cultured with the endotoxin lipopolysaccharide (LPS) with and without the addition of ursodeoxycholic acid (UDCA). The expression of iNOS, CD14 and bile acid receptor-TGR5 protein in rat liver tissues was determined by immunohistochemistry. The expression of iNOS and CD14 messenger RNA (mRNA) on the isolated KCs was detected by reverse transcription polymerase chain reaction (PCR) and the TGR5 mRNA level in KCs was measured by real-time quantitative PCR. RESULTS: The iNOS protein was markedly expressed in the liver of OJ rats, but rare expressed in SH rats. After relief of OJ, the iNOS expression was decidedly suppressed in the ID group (ID vs OJ, $P < 0.01$), but obviously increased in rats of ED (ED vs OJ, $P = 0.004$). When interfered only with LPS, the expression of iNOS mRNA by KCs was increased in the OJ group compared with the SH group ($P = 0.004$). After relief of biliary obstruction, the iNOS mRNA expression showed slight changes in the ED group (ED vs OJ, $P = 0.71$), but dropped in the ID group (ID vs OJ, $P = 0.001$). Compared with the simple intervention with LPS, the expressions of iNOS mRNA were significantly inhibited in all four groups after interfered with both LPS and UDCA ($P < 0.01$, respectively). After bile duct ligation, the CD14 protein expression in rat liver was significantly strengthened (OJ vs SH, $P < 0.01$), but the CD14 mRNA level by KCs was not up-regulated (OJ vs SH, $P = 0.822$). After relieving the OJ, the expression of CD14 protein was reduced in the ID group (ID vs OJ, $P < 0.01$), but not reduced in ED group (ED vs OJ, $P = 0.591$). And then the CD14 mRNA expression was aggravated by ED (ED vs OJ, $P < 0.01$), but was not significantly different between the ID group and the SH and OJ groups (ID vs SH, $P = 0.944$; ID vs OJ, $P = 0.513$, respectively). The expression of TGR5 protein and mRNA increased significantly in OJ rats (OJ vs SH, $P = 0.001$, respectively). After relief of OJ, ID could reduce the expression of TGR5 protein and mRNA to the levels of SH group (ID vs SH, $P = 0.22$ and $P = 0.354$, respectively), but ED could not (ED vs SH, $P = 0.001$, respectively). CONCLUSION: ID could be attributed to the regulatory function of activation of KCs and release of inflammatory mediators.

Wideman, R. F., O. T. Bowen, et al. "Influence of aminoguanidine, an inhibitor of inducible nitric oxide synthase, on the pulmonary hypertensive response to microparticle injections in broilers." Poult Sci. 2006 Mar;85(3):511-27.

The pulmonary hypertensive response to pulmonary vascular obstruction caused by intravenously injected microparticles is amplified by pretreatment with N(omega)nitro-L-arginine methyl ester (L-NAME). The L-NAME prevents the synthesis of the potent vasodilator nitric oxide (NO) by inhibiting both the constitutive [endothelial NO synthase (eNOS or NOS-3)] and inducible [inducible NO synthase (iNOS or NOS-2)] forms of NO synthase. In the present study we used the selective iNOS inhibitor aminoguanidine (AG) to evaluate the role of iNOS in modulating the pulmonary hypertension (PH) triggered by microparticle injections. Experiment 1 was conducted to confirm the ability of AG to inhibit NO synthesis by iNOS in broiler peripheral blood mononuclear cells exposed to bacterial lipopolysaccharide (LPS, endotoxin). Mononuclear leukocytes treated with LPS produced 10-fold more NO than untreated (control) cells. The LPS-stimulated production of NO was partially inhibited by L-NAME and was fully inhibited by AG, thereby confirming that AG inhibits LPS-mediated iNOS activation in broilers. In Experiment 2 we evaluated the responses of male progeny from a base population (MP Base) and from a derivative line selected for one generation from the survivors of an LD50 microparticle injection (MP Select). The pulmonary arterial pressure (PAP) was lower in MP Select than in MP Base broilers. Both lines exhibited similar percentage increases in PAP after microparticles were injected, and AG modestly amplified the PH triggered by microparticles in both lines. In Experiment 3 we evaluated the responses of

male progeny from a second base population (PAC Base) and from a derivative line selected for 3 generations using the unilateral pulmonary artery clamp technique (PAC Select). The PAP was lower in PAC Select than in PAC Base broilers, and both lines exhibited similar percentage increases in PAP in response to the microparticles. The PH triggered by microparticles was not amplified by AG but was doubled by L-NAME. These experiments demonstrate that during the 30 min following pulmonary vascular entrapment of microparticles, iNOS modulated the PH elicited in broilers derived from the MP pedigree line, but not in broilers from the PAC pedigree line. Different NOS-mediated responses among broiler populations may affect pulmonary hemodynamic characteristics of broiler lines selected using i.v. microparticle injections.

The above contents are the collected information from Internet and public resources to offer to the people for the convenient reading and information disseminating and sharing.

References

1. Arriero, M. M., A. Lopez-Farre, et al. "Expression of inducible nitric oxide synthase in the liver of bile duct-ligated Wistar rats with modulation by lymphomononuclear cells." Surgery. 2001 Mar;129(3):255-66.
2. Bonvissuto, G., L. Minutoli, et al. "Effect of Serenoa repens, lycopene, and selenium on proinflammatory phenotype activation: an in vitro and in vivo comparison study." Urology. 2011 Jan;77(1):248.e9-16. doi: 10.1016/j.urology.2010.07.514. Epub 2010 Dec 15.
3. De Winter, B. Y., A. J. Bredenoord, et al. "Effect of inhibition of inducible nitric oxide synthase and guanylyl cyclase on endotoxin-induced delay in gastric emptying and intestinal transit in mice." Shock. 2002 Aug;18(2):125-31.
4. Hess, A., W. Bloch, et al. "[Detection of nitric oxide synthases in physiological and pathophysiological processes of the nasal mucosa]." HNO. 2000 Jul;48(7):489-95.
5. Hess, A., W. Bloch, et al. "In vitro expression of inducible nitric oxide synthase in the nasal mucosa of guinea pigs after incubation with lipopolysaccharides or cytokines." Eur Arch Otorhinolaryngol. 1998;255(9):448-53.
6. Keller, A. C., D. Rodriguez, et al. "Nitric oxide paradox in asthma." Mem Inst Oswaldo Cruz. 2005 Mar;100 Suppl 1:19-23. Epub 2005 Jun 14.
7. Ma H, Chen G. Stem cell. The Journal of American Science 2005;1(2):90-92.
8. Ma H, Cherng S. Eternal Life and Stem Cell. Nature and Science. 2007;5(1):81-96.
9. Ma H, Cherng S. Nature of Life. Life Science Journal 2005;2(1):7 - 15.
10. Ma H, Yang Y. Turritopsis nutricula. Nature and Science 2010;8(2):15-20. http://www.sciencepub.net/nature/ns0802/03_1279_hongbao_turritopsis_ns0802_15_20.pdf.
11. Ma H. The Nature of Time and Space. Nature and science 2003;1(1):1-11.Nature and science 2007;5(1):81-96.
12. National Center for Biotechnology Information, U.S. National Library of Medicine. http://www.ncbi.nlm.nih.gov/pubmed. 2015.
13. Rengasamy, A., C. Kommineni, et al. "Effects of hard metal on nitric oxide pathways and airway reactivity to methacholine in rat lungs." Toxicol Appl Pharmacol. 1999 Jun 15;157(3):178-91.
14. Rodriguez, D., A. C. Keller, et al. "Bacterial lipopolysaccharide signaling through Toll-like receptor 4 suppresses asthma-like responses via nitric oxide synthase 2 activity." J Immunol. 2003 Jul 15;171(2):1001-8.
15. Schwarz, N. T., B. Engel, et al. "Lipopolysaccharide preconditioning and cross-tolerance: the induction of protective mechanisms for rat intestinal ileus." Gastroenterology. 2002 Aug;123(2):586-98.
16. Wang, Z. K., J. G. Xiao, et al. "Effect of biliary drainage on inducible nitric oxide synthase, CD14 and TGR5 expression in obstructive jaundice rats." World J Gastroenterol. 2013 Apr 21;19(15):2319-30. doi: 10.3748/wjg.v19.i15.2319.
17. Wideman, R. F., O. T. Bowen, et al. "Influence of aminoguanidine, an inhibitor of inducible nitric oxide synthase, on the pulmonary hypertensive response to microparticle injections in broilers." Poult Sci. 2006 Mar;85(3):511-27.
18. Wikipedia. The free encyclopedia. http://en.wikipedia.org. 2015.

5/15/2015