INDOMETHACIN & SARS-COV-2: PROSPECTS FOR CLINICAL MANAGEMENT OF THE INFLAMMATORY STATE. Review

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Actuality. Severe acute respiratory syndrome (SARS) is a pandemic (called SARS-CoV-2 or COVID-19), severely affected by transmission and fatal disease caused by unknown coronavirus family of RNA virus (SARS-CoV). Phenotype can range from asymptomatic to fulminate cytokine storm which leads multiorgan failure resulting death. Still the world is eagerly waiting for antiviral drug to stop the corona virus infection. Previous studies found that indomethacin had ability to inhibit the RNA and DNA virus replication.

Objectives. Discuss the possibility of clinical treatment of inflammation caused by SARS-CoV-2 with indomethacin.


Results. Interleukins, Interferons and metabolites formed by the enzyme cyclooxygenase (COX 1/COX 2) are active against some RNA viruses. Experts have divided the SARS infection in three phases (phase-1, 2, 3) based on severity of infection. In phase-3 there was “cytokine storm” due to exuberant inflammation observed which can damage organs and even fatal. We investigated that effect of indomethacin on COX inhibitor on coronavirus replication and cytokine storm in reducing the hyper inflammatory state. Indomethacin is a potent inhibitor of SARS CoV-2.

Conclusion. Indomethacin can be considered safe and effective for prevention and treatment of coronavirus infection also antiviral activity.

Key words: Indomethacin, covid-19, SARS-CoV-2, inflammation

Abstract. Severe acute respiratory syndrome (SARS) is a pandemic (called SARS-CoV-2 or COVID-19), severely affected by transmission and fatal disease caused by unknown coronavirus family of RNA virus (SARS-CoV). Phenotype can range from asymptomatic to fulminate cytokine storm which leads multiorgan failure resulting death. Still the world is eagerly waiting for antiviral drug to stop the corona virus infection. Previous studies found that indomethacin had ability to inhibit the RNA and DNA virus replication.

Objectives. Discuss the possibility of clinical treatment of inflammation caused by SARS-CoV-2 with indomethacin.


Results. The global pandemic SARS-CoV-2 started from Wuhan, CHINA which has shaken terribly the world. This virus pandemic challenged all healthcare professionals from treating infected people to prevention of infection. This corona virus rapidly infected people in china and spread all over the world. WHO declared this as pandemic disease. This coronavirus has been reported all the world and 11 419 529 cases with 533 780 deaths have confirmed with 4.674 death rate and continuing. Common symptoms of coronavirus infection were cough, fever, head ache and spurometer production. While complicated symptoms are acute respiratory distress syndrome and cardiac injuries [1]. Experts believed that SARS-CoV-2 may be transmitted from bats to humans [2]. The main host cell receptor for SARS-CoV-2 is ACE2 receptor (angiotensin-converting enzyme 2), this is the main gate for entry of coronavirus and cause infection [3,4] and pathogenesis reveals that all exposed people are infected and not all infected people develops serious problems, but completely depends on the immunity of specific person. The experts divided the infection into three phases, phase-1 asymptomatic incubation period may be or may not be with detectable virus, phase-2 symptomatic with presence of virus and need of hospital, phase-3 severe respiratory symptomatic phase with viral load and inflammation due to cytokine burst, considered as dangerous phase.

Phases of SARS-CoV-2 infection. Experts described that infection can be divided into three phases depending on severity; each phase specific therapeutic treatment may be indicated or avoided. Again this specific treatment
can be specific from person to person due to immune variation and also response of patients.

Phase 1 (asymptomatic incubation). In this phase, person has contracted SARS-CoV-2, the infection starts and the immune system responds against the virus. Initial symptoms can be cough, fatigue, fever, nausea and diarrhea. Duration of this phase can be from 3-7 days. During this phase-1, a specific adaptive immune response will be required to break down the virus replication to avoid the progress of disease to severe. Immune responses and development could be certainly most important at this phase. When patient is at this stage antiviral can be helpful to inhibit the viral load and avoid further complications with the prevention of virus replication. Most probably only antiviral could be more effective to stimulate the immune system and avoiding the use of steroid or non-steroid anti-inflammatory drugs, and being able to take into consideration the administration of immune stimulants or plasma derived from cured patients by convalescent plasma could be beneficial.

Currently, there is evidence of antivirals drugs remdesivir, lopinavir/ritonavir, chloroquine and hydroxychloroquine for efficiency against SARS-CoV-2. If the progress of infection is limited in this phase and if virus is defeated, this will be a very good chance for the recovery without further complications.

Phase 2 (symptomatic). The second phase of infection begins between the 10th and 14th day. A protective immune response of the body is impaired; the immune system was not able to protect body from the virus and deep respiratory tract infection, as the lungs.

The hypoxic phase starts; in this phase hospitalization and oxygen administration can be required. Cardiac involvement and clotting problems could take place in this phase and patients with underlying heart disease could have a greater risk of entering the serious clinical picture. Laboratory tests show a decrease in lymphocytes, an increase in transaminases and a moderate increase in pro-inflammatory markers.

The treatment that could be indicated is a continuous use of anti-viral drugs and, when the respiratory situation worsens, need to be started the support of oxygen and/or use of anti-inflammatory drugs, antibiotics and the administration of LMWH (Low-molecular-weight-heparin) to prevent thromboembolic events.

Phase 3 (severe). The third stage is the most serious, which can lead to the death of the patient. In this phase there is a hyperactive and systemic (not only lung) inflammatory state which is called Cytokine Storm (CS) and that can appear in the patient and, briefly, lead to respiratory distress syndrome (ARDS). In this phase inflammation marker values (IL-2, IL-6, GCSF, TNF-alpha, D-dimer, ferritin, etc.) are very high. The patient may have severe respiratory failure and cardiac shock. All the organs of different systems may see a worsened condition. Immunological therapies (corticosteroids, anti-interleukin 6, such as tocilizumab and sarilumab, IL-1 receptor antagonists such as anakinra or canakinumab, JAK-inhibitors, convalescent plasma transfusion) are necessary at this severe stage to attempt the reduction of an aberrant storm cytokin response. The prognosis for patients at this stage of disease is very severe [5-9].

Indomethacin. Indomethacin is an inexpensive drug, non-selective cyclooxygenase (COX) inhibitor that can inhibits COX-1 and COX-2 which catalyses the production of prostaglandins, and also used to treat a variety of inflammatory conditions. Indomethacin is a potent anti-inflammatory agent, anti-viral and inhibits COX enzymes more potently than aspirin [10] with other mechanisms like inhibiting movement of PML (Polyomorpho nuclear leucocytes), multidrug resistance protein. Amici et al. confirmed indomethacin possesses antiviral activity in vitro against SARS CoV (severe acute respiratory syndrome coronavirus) in monkey VERO cells as well as in vivo activity at relatively low doses (1 mg/kg) against canine coronavirus (C CoV) in dogs and also indomethacin possesses direct antiviral activity for SARS CoV and C CoV by blocking viral RNA synthesis many folds. Indomethacin is a NSAID which was introduced in the 1965 by FDA and has been used broadly for the treatment of pain and inflammatory conditions. There is a rational basis for the use of indomethacin in the treatment of Covid-19, in preference to other NSAIDs [11].

United State have been using indomethacin in the treating the COVID-19 symptoms for some time and now have experienced of using the indomethacin in more than 60 patients. Among Dr Jonathan Leibowitz, Dr Robert Rothstein and Dr Aline Benjamin, have shared their insights and experiences while treating the patients of COVID-19 [12].

Indomethacin, however, can also induce other side effects such as gastritis, renal dysfunction and platelet dysfunction,[13]which could be detrimental to COVID-19 patients with severe SARS-CoV-2 infection, especially if patients have multiorgan dysfunction/ failure resulting from cytokine storm (C.S). Furthermore, some authors have reported that NSAIDS such as ibuprofen may be detrimental in patients with SARS-CoV-2, causing more severe infection or leads to later complications such as emphysema, prolonged hospital stay, or lung cavitations, as has been reported in patients with bacterial pneumonia [14, 15]. However, the WHO recently did not recommend against ibuprofen use for infection with SARS-CoV-2 [16]. Some studies have shown ibuprofen to cause decrease in sputum IL-6 in cystic fibrosis patients [17] and synovial fluid IL-6 in patients with knee osteoarthritis [17], which demonstrates that NSAIDS can lower IL-6 in human fluids. This lends biologic plausibility that COX inhibition with indomethacin could lower IL-6 levels in nasopharyngeal-respiratory tract secretions. Whether using lower doses of indomethacin (starting with 25 mg 3 times daily) at first sign of infection (in outpatients
after a positive nasopharynx swab confirmation) or for IPD with adequate organ function and no evidence of cytokine storm is conjectural, but use of this agent along with gastric protective agents (e.g., H2 blockers) may be prudent. Since cytokine storm is result of basically an inflammatory response, well-timed blunting of this cascade with indomethacin could conceivably lower inflammatory mediators such as TNF and IL-6 as well as superoxide free radicals, which invoke the cellular damage [13]. Perhaps a clinical strategy would be to monitor IL-6 levels (or C-reactive protein [CRP] as a surrogate marker), upon admission in noncritical patients and start indomethacin when IL-6 (or CRP) begins to rise, and subsequently monitor levels daily. Indeed, well-timed anti-inflammatory agents such as NSAIDS and corticosteroids have been suggested to reduce systemic inflammation prior to the development of overwhelming systemic inflammation/cytokine storm [18]. Indomethacin could be used alone or more likely, as an adjunct to antiviral therapy such as remdisivir, in noncritical patients. It would be interesting to monitor time to clearance of the antigen from upper respiratory secretion, antibody kinetics, and duration of symptomatic disease in patients treated with indomethacin. Given the cost and availability of this agent, indomethacin may warrant study in outpatients or admitted patients with documented infection with SARS-CoV-2 without evidence of cytokine storm.

Mechanism of action of Indomethacin. Indomethacin (INDO) is an NSAID and functions like most other NSAIDs. The effect of indomethacin is due to inhibition the synthesis of prostaglandins. Prostaglandins are produced primarily by the cyclooxygenase (COX) enzymes, and these prostaglandins are very critical mediators of inflammation, fever and pain, also involved in maintaining different system function (renal function, GI mucosa, and platelet activity-inhibition of this enzyme) by NSAIDs. COX-1 involvement in the production of thromboxane A2 (a critical mediator of platelet aggregation) – thus, inhibition of this enzyme is likely responsible for the anti-platelet effects of NSAIDs. COX-1 appears for maintenance of GI mucosa, while COX-2 seems to be upregulated in inflamed tissues, and responsible for the production of prostaglandins which cause inflammation, fever and pain. Although COX-2 selective NSAIDs may have fewer GI associated side effects, indomethacin is a non-selective COX inhibitor [19].

The NSAID Indomethacin has a potent antiviral activity against different coronaviruses, being effective against the canine (CCoV) and the human (SARS-CoV) coronaviruses [20]. Moreover, INDO does not affect directly virus infectivity, binding to ACE-2 receptor or entry into target cells through respiratory system, but acts very early on the coronavirus replication cycle, selectively blocking viral RNA synthesis. INDO has been used for a long time as a potent anti-inflammatory drug, acting by blocking COX-1 and COX-2 activity and inhibiting pro-inflammatory prostaglandin synthesis [21]. The antiviral effect, however, appears to be cyclooxygenase-independent, since it occurs at concentrations higher than those needed for COX inhibition (10-8,10-9M) [22]; in addition, the antiviral activity cannot be mimicked by the potent COX inhibitor Aspirin, which has no effect on either CCoV or SARS-CoV replication up to millimolar concentrations. Indomethacin has anti-viral activity; it down-regulates viral replication, and literature showed its anti-viral activity against rhadbovirus vesicular stomatitis virus, hepatitis B virus and coronavirus [22, 23]. Indomethacin (and most other NSAIDs) can impact most organ systems of the body (gastrointestinal, neurological, renal, hematologic and cardiopulmonary systems). As previously mentioned indomethacin is a non-selective COX inhibitor, and COX-1 is responsible for the production of prostaglandins involved in the maintenance of the gastric mucosa. Inhibition of this process can result in dyspepsia (indigestion), nausea, constipation, and diarrhea [24].

Although no randomized trial data was available for indomethacin for treatment or slowing progression of SARS-CoV-2 infection, these agents should be considered by the medical community as potentially worthy of further study as therapeutic adjuncts, given the relative safety, accessibility, and cost effective. As SARS-CoV-2 infection can be divided into three phases: phase 1, an asymptomatic or slightly symptomatic incubation period with or without detectable virus; phase 2, slightly symptomatic period with presence of virus; phase 3, severely symptomatic respiratory phase with high viral load and generalized hyperinflammatory state. The third is the most severe and dangerous described by a generalized hyperinflammatory state, a sudden release of cytokines into the circulation defined as «cytokine storm» (CS). Waiting to find antivirals directed against SARS-CoV-2, evidence has shown that reducing or stopping the hyperinflammatory state that occurs in some infected patients is effective in improving health. We believe that it is of utmost importance to properly manage the inflammatory/immune status of the infected patient. The use of indomethacin, as well as its proven efficacy in the prophylaxis and treatment of autoimmune inflammatory diseases such as FMF or pericarditis, could be considered in all three stages of SARS-CoV-2 infection, especially in those patients at high risk of developing serious lung complications in a dramatically short time, in monotherapy or in combination, carefully monitoring possible drug interactions. Indomethacin, if used in the recommended doses, could be in monotherapy or in combination a safe and effective treatment for the prevention or reduction of cytokine storm in sars-CoV2. However, we believe that a combination of several drugs, each at a lower dosage than monotherapy, may be the most effective and tolerable solution to manage the patient’s inflammatory state, particularly in phases two and three.
CONCLUSION

Indomethacin can be considered safe and effective for prevention and treatment of coronavirus infection also antiviral activity.

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ІНДОМЕТАСІН & SARS-COV-2: ПЕРСПЕКТИВИ КЛІНІЧНОГО ЛІКУВАННЯ СТАНОМ ЗАПАЛЕННЯ. Огляд

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Актуальність. Важливий гострий респіраторний синдром (Severe acute respiratory syndrome – SARS) характерний для пандемії, зв'язаної з SARS-related coronavirus 2 (SARS-CoV-2), або CoronaVirus Disease-19 (COVID-19), і викликаної невідомим сімейством РНК-вірусів – коронавірусом (SARS-CoV-2). Фенотип може варіювати від бессимптомного до ближнього щитокинового шторму, який призводить до поліорганної недостатності та смерті. Відомо, що індумейції має здатність пригнічувати реплікацію РНК і ДНК вірусів.

Мета: обговорити можливість клінічного лікування запалення, викликаного SARS-CoV-2, за допомогою індометазину.


Результати. Інтерлейкіни (IL), інтерферони (IFN) і метаболіти, утворені ферментом циклооксигеназою (COX 1 / COX 2), активні проти деяких РНК-вірусів. Експерти розглядали інфекцію SARS на три фази (фази 1, 2, 3) в залежності від ступеня тяжкості. У фазі 3 спостерігається «щитокиновий шторм» через сильне запалення, але може поширити орган і навіть привести до летального результату. Індумейції може пригнічувати синтез простагландинів, виробляваних циклооксигеназою, пригнічує реплікацію коронавірусу і цитокіновий шторм і знижує вираженість гіперзапального стану. Індумейції є потужним інгібітором ТРВІ СОВ-2.

Висновок. Індумейції, що має противірусну активність, можна вважати безпечним і ефективним для профілактики і лікування коронавірусної інфекції.

Ключові слова: індометазин, COVID-19, SARS-CoV-2, запалення.

ІНДОМЕТАСИН I SARS-COV-2: ПЕРСПЕКТИВИ КЛІНІЧНОГО ЛІЧЕННЯ СОСТОЯНИЯ ВОСПАЛЕНІЯ. Обзор

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Актуальность. Тяжелый острый респираторный синдром (Severe acute respiratory syndrome – SARS) характерен для пандемии, называемой SARS-related coronavirus 2 (SARS-CoV-2), или CoronaVirus Disease-19 (COVID-19), и вызванной неизвестным семейством РНК-вируса – коронавирусом (SARS-CoV-2). Фенотип может варьировать от бессимптомного до миелопоренческого шторма, который приводит к полиорганной недостаточности и смерти. Известно, что индометазин обладает способностью подавлять репликацию РНК и ДНК вирусов.

Цель: обсудить возможность клинического лечения воспаления, вызванного SARS-CoV-2, с помощью индометазина.


Результаты. Интерлейкины (IL), интерфероны (IFN) и метаболиты, образованные ферментом циклооксигеназой (COX 1 / COX 2), активны против некоторых РНК-вирусов. Эксперты разделили инфекцию SARS на три фазы (фазы 1, 2, 3) в зависимости от степени тяжести. В фазе 3 наблюдается «цитокиновый шторм» из-за сильного воспаления, которое может повредить органы и даже привести к летальному исходу. Индометазин может уменьшить синтез простагландинов, вырабатывающихся циклооксигеназой, подавляет репликацию коронавируса и цитокиновый шторм и снижает выраженность гипервоспалительного состояния. Индометазин – мощный ингибитор SARS-CoV-2.

Вывод. Индометазин, обладающий противовирусной активностью, можно считать безопасным и эффективным для профилактики и лечения коронавирусной инфекции.

Ключевые слова: индометазин, COVID-19, SARS-CoV-2, воспаление.

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