Anti-adhesion therapy, a promising alternative in the infections treatment.

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ABSTRACT

Objective: Antibiotic resistance (AR) represents one of the most important health problems worldwide due to the fact that it significantly lowers the number of effective antibacterial agents. Many mechanisms were studied to reduce emerge of AR, one of these is the use of Anti-adhesion

Methods: keywords were used to search Most of the subject available articles. Following that, a grammatical examination was done for the vocabulary associated with the literature review.

Results: Anti-adhesion agents represent vital approach to stop or treat bacterial infections. As these agents focus on bacterial virulence and pathogenicity properties (e.g. adhesion and colonization).These agents considered a perfect alternative for an antibiotic, with the infectious process inhibiting advantage in the first step to reduce the damage. These agents inhibit bacteria attachment to the surface of the host cell through interfering with the assembly of host receptor, bacteria-host cell assembly or adhesion biosynthesis. Bacterial adhesions antibodies can prevent surface epitopes required for bacteria-host cell attachment by the application of anti-adhesion strategy to decrease AR or reduce the need for the effective antibiotic doses .

Conclusions: Anti-adhesion therapy includes efforts for preventing adherence, reduces virulence, and biofilm formation. These have advantages over classical antibiotics through blocking pathogenicity without destroying bacteria and it also have a synergistic effect when applied with antibiotics

Keywords: Anti-adhesion therapy, Adhesions, Antibiotic resistance, Anti-adheres mechanisms.

العلاج المضاد للالتصاق ، بديل واعد في علاج الاصابات

الملخص

الهدف: تمثل مقاومة المضادات الحيوية (AR) واحدة من أهم المشاكل الصحية في جميع أنحاء العالم وذلك لانها تسهم بشكل كبير بتقليل عدد العوامل الفعالة المضادة للبكتيريا. تمت دراسة العديد من الآليات للحد من ظهور AR ومنها استخدام عوامل مضادة للالتصاق.

طرائق العمل: تم البحث في معظم المقالات المتاحة باستخدام كلمات البحث الرئيسية. هنا ، استعرضنا استراتيجيات مختلفة من العلاج المضاد للالتصاق. بعد ذلك ، تم إجراء فحص نحوي للمفردات المرتبطة بمراجعة الأدبيات.

النتائج : والتي تمثل استراتيجية مهمة لمنع أو علاج الاصابات البكتيرية نظرًا لأن هذه العوامل تركز على خصائص ضراوة البكتيريا (مثل الالتصاق وبناء المستعمرات). اعتبرت هذه العوامل بديلاً مثالياً للمضادات الحيوية ، ذات ميزة تثبيط عملية العدوى في الخطوة الأولى لتقليل الضرر. هذه العوامل تمنع ارتباط البكتيريا بسطح خلية المضيف بالتدخل مع عملية تجمع مستقبل المضيف أو تجمع الالتصاق بين البكتريا وخلية المضيف أو التخليق الحيوي للالتصاق. يمكن أن تمنع الأجسام المضادة لالتصاقات البكتيرية المستضدات الفوقية المطلوبة لربط البكتريا مع خلية المضيف عن طريق تطبيق استراتيجية مكافحة التصاق لتقليل AR أو تقليل الحاجة إلى جرعات فعالة من المضادات الحيوية.

الاستنتاجات : نستنتج من ذلك، ان العلاج المضاد للالتصاق يتضمن محاولات لمنع الالتصاق وتشكيل الأغشية الحيوية ويقلل الضراوة. هذه لها فوائد أكثر من المضادات الحيوية التقليدية عن طريق تثبيط الإمراضية دون قتل البكتيريا وأيضا يكون لها تأثير تآزري عند تطبيقها مع المضادات الحيوية.

الكلمات المفتاحية : العلاج المضاد للالتصاق ، التصاقات ، مقاومة المضادات الحيوية ، آليات مكافحة الالتصاق.

1. Introduction

Antibiotic resistance developed when microorganisms such as bacteria, fungi or viruses not affected when they exposed to antibiotic drugs that used as standard practice to treat the infections they cause. These microorganisms cause persist of infections in the body and elevate the risk of spreading to other people. In both developing and developed countries, bacterial infections considered one of the major cause of morbidity and mortality. The irrational excessive use of antibiotics results in antibiotic resistance, which substantially reduces the number of effective antibacterial agents. Thus, the need increased to search for modern antibiotics that have the ability to bypass the mechanisms of microbial resistance. The bacterial-host cells or tissue adhesion represent the initial step of the infection [(1)].

Anti-adhesion agents represent a significant strategy to block or treat bacterial infections. As these agents focus on bacterial virulence and pathogenicity properties (e.g. adhesion and colonization). Such agents considered a good substitute for antibiotics[(2)], with the benefit of infectious process inhibiting to reducing the damage[(3)]. These agents inhibits the bacteria-host cell attachment through interfering with receptor assembly, receptor adhesion assembly or receptor adhesion biosynthesis of the host. These agents inhibit bacterial attachment to the host cell surface by interfering with the assembly, adhesion assembly or biosynthesis of the host receptor. Bacterial adhesion antibodies may prevent the brequired surface epitopes for attachment[(4)].

2. Overview of bacterial adhesion

Adhesion and colonization are important steps for bacteria pathogenicity. Adhesion is important process for the pathogen to initiate the infection. Colonization and subsequent steps promote virulence and toxin delivery to the cells of the host and also support the bacteria in place and resist the host immunity . Several species of gram-negative bacteria for example inject various types of proteins into the host cells to maintain its position[(1)]. Human body have different clearance mechanisms that inhibit bacterial adhesion, for example flow of urine in the urinary system or respiratory tract airflow and upper epithelial cell shedding of fallopian tube are all natural cleansing mechanisms of the host. The sphinganines, which are hydrophobic sphingolipids molecule act as anti-adhesion ability especially in innate immunity and play a major role in decreases adhesion *of Streptococcus mitis* and *Staphylococcus aureus* to the mucosal cells nasal cavity and buccal epithelial cells respectively[(5)]. Sphinganines attaches to the infectious agents specifically, seize them in the mucus as a result prohibiting there attachment to the sub epithelial cells[(6)]. The host cells also inihibt the pathogenic adhesion by mucus flow and removal mechanisms[(7)]. Certain sulfated component has been identified in the gastric mucus have ability to inhibit the bacterial cell attachment to the host cell[(8)]. However, bacteria possess anti-adhesives resist this mechanisms as bacteria need the host for nutrients and replication[(9)]. Bacterial adhesives attachment with an appropriate receptor in facilitate the interaction between the pathogen and host. Thus bacteria will recruit the host environment to support their physiological and metabolic requirements facilitate pathogen growth, colonization, internalization and biofilm formation[(10)].

Bacteria binding to the cell take place in multiple adhesions. Bacterial adherence mechanisms include:

1. The bacteria bypass the electrostatic repulsion forces as both host and bacteria cells are negatively charged at physiological pH producing a repulsive

force thereby creating a non-specific attachment by utilizing hydrophobic molecules. Attachment includes hydrophobic as well as other interactions that are non-specific which are primarily involved in the initial ' reversible ' phase of the cycle[11].

Bacteria can be adhered to further than one target surface and can use more than one adherence to attach to a substrate Multiple adhesions can be expressed at various levels through the infection [12].

2. Hard docking adhesions can be polysaccharide or protein[13]. Interaction of protein to protein is one of a specific adherence that demand protein adhesions to the structural extracellular matrix or proteins that emerging with the wounds[14].
3. Phosphocholine connections are other adhesions, since Streptococcus pneumonia includes phosphocholine on their cell surface which in turn bound to the receptor of the platelet-activating factor[15].
4. The most important adhesion mechanism involve surface lectins, which act as virulence factors for infectious agents and prevent such lectins through their analogs or appropriate carbohydrates to prevent and treat the infections is the goal of such strategy[4].

3. Anti-adheres mechanisms

3.1. Interfering with biogenesis of the surface receptor

The changing in the surface physical and chemical properties of the bacteria will degrade receptor biogenesis of the pathogen and reduce bacterial-host cells adherence. Chaperone-usher-pili, considers one of the most important virulence factor present in *Klebsiella, Escherichia coli, Yersinia, Pseudomonas, Haemophilus*, and *Salmonella* species. Pilus assembly inhibition considered a creative strategy for infection prevention[16].

An artificial peptide Designing similar to pilus protein structure can prevent or inhibit the assembly of the pilus through disrupting the caperon-pilin complex[17]. Curlicides and pilicides considered an important factors interferes with the pili synthesis and assembly in the chaperone–usher by many pathways and various metabolic compounds [18].

3.2. Interfering with the biogenesis of t he host receptor

Most adhesion molecules and toxins of the bacteria use host glycosphingolipid receptors to bind to the membrane[19]. Host cell structural alteration of glycosphingolipids has been proposed as one of the strategies to treat or even prevent infections through utilization of inhibitory enzymes in the biosynthetic pathway of the glycosphingolipids[20].

In lipid storage disorders patients, enzymatic and non-enzymatic glycosylation inhibitors have been shown to be effective and safe for infection prevention[21].

4. Strategy for anti-adhesion therapy

sensitive bacteria growth is prevented by antibiotics, while resistant strains may keep increasing and even transmit to new ho sts. In untreated individuals, normal (wild type) strains clash with resistant strains and work to avoid resistance widespread[3]. Antibiotics resistance spontaneously arises in a populations by random mutation. Constant antibiotic use will lead to the destruction of all sensitive microbes. Only the organisms with the proper mutation can survive. There for, quick spreading of resistance in a population will be the final result. As for anti-adhesive therapy, viability of the sensitive bacteria will be observed, and antibiotic treatment resistance reported to happens at a quite slower rate[10]. Through host cells attaching, bacteria can withstand the body's behavior

of cleaning processes, causing themselves to achieve a density in which infection can occur. As for anti-adhesion therapy, it would eliminates this interaction, which allows the host to expel the pathogen and thus prevents disease. A variety of strategies have been proposed to kill bacterial adhesion, such as t he covering of the target substrate[22], affecting adhesion biosynthesis[3], modifying the surface anchoring [23], affecting the targeted substrate glycosylation[24], use of adhesion analogs or anti-adhesion antibodies[25,26].

All of these novel strategies aimed at preven ting and treating infectious diseases of the bacteria.

4.1.Receptor analogs an anti-adhesive agent

Interactions of bacterial to the host mostly mediated via carbohydrates. Superficial carbohydrates of the bacteria involve glycoproteins, lipopolysaccharides and capsules, whereas carbohydrates of the host surface contains glycosphingolipids and glycoproteins. Research has therefore concentrated on synthetic and glycomimetics glycosides use serve as anti-adhesives[27]. Availability of a significant amount of receptor analogs throughout the microbial environment generates a competitive inhibitor state for host receptors that interacts with adhesion of bacteria[4]. Mannose has shown to be an enterobacteria receptor. Many unique sugars may be used as receptors for special bacteria and it may contribute to receptor-like carbohydrates development Inhibit the adherence of infectious agents to host cells. Several studies reveled that sugar analogs concentrations for adhesion inhibiting are generally high due to the fairly low affinity of these molecules to target adhesion. Such a problem can be solved through attaching saccharide and hydrophobic residues together. Affinity may be enhanced through connecting the saccharide to the correct carrier. The mannose affinity is 100 times higher for adhesion of *E. coli*'s FimH when attached to Alkyl group to become Alkyl-substituted mannose[26]. Pharmacokinetic tests have shown that such approaches are effective for UTI therapy in the murine model, with colony-formation decreases compared to those achieved through the ciprofloxacin[27].

Two approaches have been used to increase the effectiveness of FimH inhibitors due to the anti-adhesive weak inhibition (monovalent inhibitors logical design with agglutination components and multivalent compound formulation with enhanced attachment avidity to improve affinity)[28]. Methyl K-mannoside Administration altogether with *E. coli* expressing mannose-specific type 1 fimbrial lectin in the mice bladder reduced its UPEC colonization [3]. Furthermore, anti-adhesions decrease the mortality and damage in the lung damage murine model induced by *P. aeruginosa* bacteria. This was appropriate due to the adhesion reduction of *P. aeruginosa*, which result in bacterial burden and spread reduction[29]. Researches demonstrated that Sialyl-3P-lactose is a is a pretty specific, selective and, safe molecule against *Helicobacter pylori* adhesion to human gastric cell culture[30]. Despite that, this was not completely successful in trials. The possible explanation might be that numerous adhesions were consumed by the microbes through infection. Different specificities has been added to this and therefore preventing adhesion takes several inhibitors. A drug These have different specificities and therefore preventing adhesion takes several inhibitors. A mix of several sugar receptor analogs is considered to be the very first realistic approach for such a type of treatment in the future, which is yet to be resolved.

Cells of different tissues, including gastrointestinal epithelial, are constantly experiencing a high flow rate, that can removes sugar through mimicking protection

removal. Another protective mechanism verses bacterial diseases is the physical barrier verses pathogen colonization. Various mucin glycoproteins are found in mucus that are secreted from the intestinal epithelial cells. Mucins, in turn, act through attaching and disable bacteria and therefore functions as an adhesion inhibitor[31].

4.2.Peptide inhibitors

Streptococcus mutans express the protein antigen (SA) I / II, which considers an important factor for S.mutans attachment to the receptors of the salivary glandes. Adsorption of these surface proteins on the teeth matrix surface, where monoclonal antibodies produced against (SA) I/II, which may inhibit adsorption to the teeth[32]. The connection between host cell and bacteria inhibition by 65–85 percent using designed peptide. This method is very effective in the prevention of caries and other streptococcal infections[33]. MAM7 is another target of peptide-based anti-adhesive development. MAM7-coupled polymers were used to minimize surface attachment and pathogen infection, like *Vibrio parahaemolyticus*, *Vibrio cholerae*, (EPEC), and *Yersinia pseudotuberculosis*[34]. Fzeon is an HIV fusion inhibitor peptide that inhibits the viral particles merging to the host cells[35]. Studies revealed that this approach can be successful anti-adherence therapy when applied to a particular infectious agents.

4.3. Dietary anti-adhesion

Several food components were separated and revealed to have a beneficial impact toward several bacterial infection[1]. Cranberry juice serves to protect toward bacterial infections such as UTIs. Polyphenols and Pro-anthocyanidins have been shown to be biologically active compounds in cranberries[38]. Pro-anthocyanidins prevent co-aggregation and adhesion of *H. pylori*, UPEC, and *Porphyromonas gingivalis*[39]. Polyphenols and pro-anthocyanidins could attach with flagella or pili, thereby inhibiting attachment of bacterial surface, swarming movement and aggregation onto biofilms. Many Other products, like wine, tea, coffee and plantains, contain anti-adhesion substances[2]. Dietary products containing a combination of inhibitors or a single inhibitor with a wide range of action.

4.4.Anti-adhesion vaccines and antibodies

Several studies have found antibodies to microbial adhesions that have been utilized as an anti-adhesion mechanism. The host might be immunized directly or indirectly indirectly by microbial adhesions adhesions. Vaccination could be achieved with a DNA encoding vaccines[1]. DNA vaccines include DNA that encodes for an antigen of a specific protein that, when expressed in the host, is capable of creating protective immunity. Vaccinations stimulate humoral as well as cellular immunity against the microorganism. The bacterial infections Prevention is based on adhesion. Vaccination can be accomplished via several approaches. A study revealed that, FimH-based UPEC vaccines immunization prevented 99 percent of infections incidence in murine cystitis mice.

4.5.Receptors & adhesions inhibitors

We have to block bacterial adhesion and inhibit attach ment to the host cells in order to stop bacterial colonization and infection. There are many possible targets for the drugs that could inhibit such molecules formation (Figure 1). Pilicides are toxins that block the usher-chaperone pathway in pathogens. The inhibitor attacks PapD pilus caperone, thus decreases 90 percent of adhesion to cell line[40]. Those pilicides disrupt the formation of curli in UPEC through stopping the polymerization of the chaperone protein of type I pili[41]. Sortase, which is a bacteria Gram-positive enzyme, induces adhesions as well as pili formation, thereby, sortase is indeed the target for many inhibitory drugs[42].

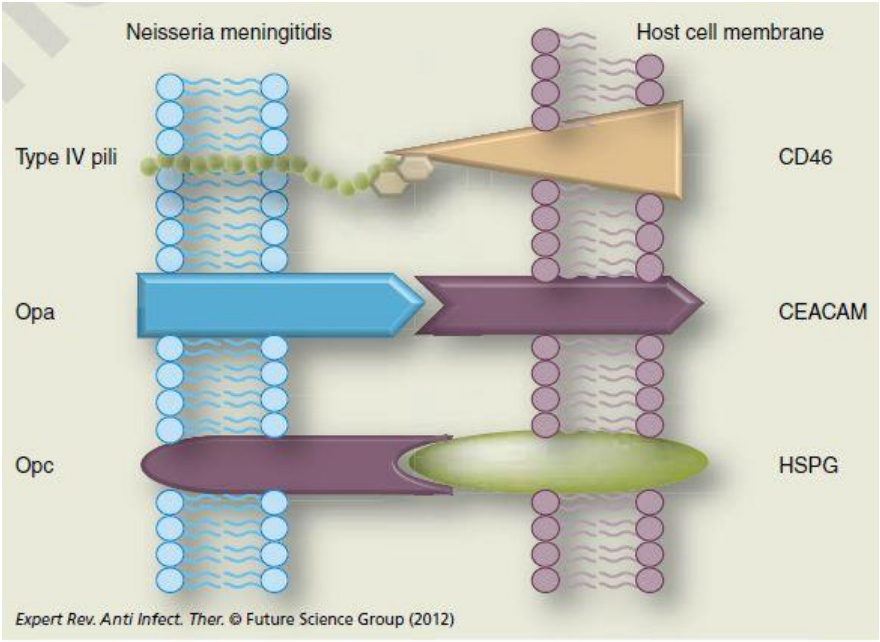

Figure 2. The major three adhesions sites of *Neisseria Meningitidis* and their related receptors, Whose attachment leads to binding of the bacterial. CEACAM: Carcinoembryonic antigen cell adhesion molecule; HSPG: Heparin Sulphate Proteoglycan; Opa: Opacity-associated Protein.

4.6.antibiotics Sub-lethal concentrations

Studies indicate that minimal antibiotic concentrations below the amount that needed for killing bacteria or microorganism may affect adhesions biochemical and the bacterial surface properties and antibiotics sub minimal inhibitory concentration that minimize attachment to multiple surfaces[43]. Ciprofloxacin Sub-MIC levels against UPEC strains causes a decrease in the bacterial surface hydrophobic nature [44]. Antibiotics in fact increase the dhesion level of some bacteria to catheters such as UPEC. Oxacillin Sub-MIC level for *S. aureus* treatment has significantly increased adherence. On the other hand, sub-MIC reduces adherence. Treatment rifampin decreased the binding of fibronectin of *S. aureus* and diminished the bacteria adhesion to the host surface[45]. Rapid development of antibiotic resistance would be another issue with the sub-MIC use of antibiotics, where antibiotic resistance is more frequently to occur under sub-MIC conditions[46].

4.7.Dietary supplements adhesion inhibitors

Many supplements that inhibits bacterial adherence molecules can be located in many natural foods. Such dietary supplements may be used as anti-adhesion factors. There is no well-known mechanism of action, but there might be analog of receptors and inhibitor of adhesions[2]. The most explored dietary supplement is cranberry, particularly in terms of dental decay and UTIs. Cranberry polyphenols have been shown to reduce a number of bacteria attachment such as E. coli.[47]. Women who may have ingested cranberry juice throughout a long period of time have shown reduced incidence of bacteriuria[48]. Milk includes antibodies,

glycoproteins, and oligosaccharides that may decrease bacterial attachment. **S**everal pathogens are well known to attach to such a compounds which inhibit their potential to colonize and attach to host cells[49]. Human milk is rich in oligosaccharides, which inhibit the attachment of the pathogenic bacteria as well as common enteric pathogen Salmonella fyris,E. Coli, and V. cholera to cell lines of epithelial[50]. Bovine Muc1that extracted from milk of cows effectively inhibit microbial infection. However, there efficient in preventing Gram-positive microbes as *S. aureus* and *Bacillus subtilis* is not well , but, it prevents the Gram-negative organisms binding such as *Salmonella Typhimurium* and *E. Coli*[51].

4.8.Probiotics as an anti-adhesive factors

Probiotic is a beneficial bacteria that block microbes from achieving the essential density needed to cause infection. They may act to decrease the attachment of pathogenic microbes. Probiotic bacteria could eliminate harmful bacteria as well as compete with it for vital growth nutrients[52]. Probiotics were specifically meant to mimic sugars on target receptors in order to block host cell attachment of toxins produced by pathogenic bacteria, such as *E. coli*(STEC), *ETEC,V. cholera*, and shigella toxin-producing[53]. However, the mechanism of probiotic action is difficult to understand. Probiotics can prevent pathogen adherence by affecting other pathogenesis components and by activat ing the innate immunity[54].

4.9.Glycoconjugates and glycomimetics

The most important factor of microbes ability to induce infection is the adhesion factors attaching to the host cell. Bacterial adhesion molecules found on the microbial surface or on its fimbriae and pili interfere with particular glycans in the host cells. This attachment Inhibition considered an anti-adhesion target for therapies in many infections. The use of appropriate materials that are resistant to environmental state is of great importance. Natural substances for instance can reduce resistance to the destruction by enzymes. Suitable substances should, therefore, be utilize to resolve such a problem. The glycomimetics used as a substitute for traditional sugars that result in higher metabolic selectivity and stability toward the protein goal of desire(4). Efficient anti-adhesion treatment needs a high-affinity monovalent lectin and multivalent compounds containing multiple versions of ligand receptors of mild affinity to a polyvalent scaffold (nanoparticle, polymer, and dendrimer)[55].

Table 1. past studies of bacterial anti-adhesion inhibitors.

Material group	Animal	mechanism	Location	Year	Ref.
Multivalent adhesion molecule (MAM) 7 coupled polystyrene	In vivo rat model	Blocking assembly or function of pilus *P. aeruginosa*	UK	2017	(56)
PilQ/PilA (QA) antigen of *P. aeruginosa*(vaccine)	In vivo mouse model	Anti-pili in *P. aeruginosa*	Iran	2017	(57)

Chitosans (AUM-CS) interacts with negatively charged compounds	In vitro	*K. pneumoniae*and *E. coli*	Italy	2017	(58)
Salvianolic acid B (SAB)	In vitro	Anti-pilli of *Neisseria meningitidis*	Finland	2016	(59)
Quercetin	In vitro	*B. subtilis*(prevent bacteria-surface electrostatic attachment through preparing repulsive surfaces)	Egypt	2016	(60)
Phaleria macrocarpa	In vitro	*S. mutans*	Malaysia	2015	(61)
Essential oils (EOs)	In vitro	*Salmonella*	Tunisia	2015	(62)
Monoclonal 11B9/61 antibody	In vitro	Pneumococcal type I pilus (RrgA)	America	2015	(63)
Peptide P2 Peptide P3	In vitro	AAF-II adhesion of EAEC	India	2015	(64)
Calixarene-based glycoclusters	In vitro In vivo mouse model	Anti-pilli *of* *P. aeruginosa*	France	2014	(65)
Cranberry bioactives	Ex vivo	P-fimbriaL of *E. coli*	New Jersey (United States)	2013	(66)
Synthetic-mannosides	In vitro	FimH of *E.coli*	Germany	2013	(67)
Flavonoid rich extract of *Glycyrrhiza glabra*(GutGard)	In vitro	*H. pylori*(inhibit DNA gyrase, dihydrofolate reductase, Protein synthesis)	India	2012	(68)
S-carboxymethylcysteine (*S*-CMC)	In vitro	Platelet-activating factor receptor (PAFR) of *S. pneumoniae*	Japan	2011	(69)
Melanoidin and non-melanoidin components in coffee	In vitro	*S. mutans*	Italy	2010	(70)
Cranberry	In vitro	P-fimbria of *E. coli*	France	2010	(71)

Probiotic Lactobacillus rhamnosus GG and *Lactobacillus gasseri*	In vitro	*S.*Typhimurium	USA	2009	(72)
Wine components	In vitro and ex vivo	*S. mutans*	Italy	2009	(73)
Sialyloligosaccharides (SOS)	In vitro	*V. cholerae*toxin (Ctx)	United Kingdom	2009	(74)
Monosaccharide	Invivo animal model	PA-IL and PA-IIL of *P. aeruginosa*	France	2008	(75)
Ceramic-composite	In vitro	*S. mutans*NCTC 10	Germany	2007	(76)

5. Anti-adhesion therapy advantages and disadvantages

Microorganisms adhesion is a key step in infection and is mainly mediated via protein-carbohydrate interactions. Preventing these interactions appears to be a promising target of anti-adhesion treatment in a variety of infectious diseases. Polyvalent glycoconjugates provide many of the effective anti-adhesive materials, whereas interactions of monovalent protein-sugar are not strong[77]. Anti-adhesion treatment does not elevate microbial resistance because it only prevents microbial attachment to the surface but do not influence microbial activity. This method inhibits biofilm formation and invasion but does not destroy the invasive pathogen, so selective pressure and resistance do not develop for anti-adhesion[4]. It is evident that the existence of several microbial adhesion molecules, as well as the lack of adequate strategies for administering inhibitors to all adhesion molecules, are a huge obstacle to anti-adhesion strategy. Other issues seem to be the weak affinity of unoccupied receptors to microbial ligands as well as the adhesion of popular epitopes to the proteins of human.

Mutations can occur and may influence the effectiveness of anti-adhesion substances. These would even impact the ability of the mi croorganism to bind directly to the host cell receptor. Point mutations in microbial adhesion molecules may affect tissues in the human body. This problem consideration tells us of the nature of strain-specific as well as anti-adhesive substances that are species-specific to prevent side effects arising from macrobiotics changes.

Environmental resistance conditions is another advantage of this approach. In fact, anti-adhesion agents do not have negative health effects on the host cell but they aren't bactericidal ether[78] .

Conclusions

Antibiotic misuse has led to esistant strains development, and most of the treatable disease is now a problem. Anti-adhesion treatment includes efforts to block adherence, virulence, and biofilm formation. Those have advantages over conventional antibiotics through suppressing pathogenicity without destroying bacteria. Microbes and bacteria use a wide variety of adherence molecules throughout the adhesion process, thus, numerous molecular interactions might had been blocked to optimize the elimination of the infectious agent from the body. In some cases, failures have occurred in spite of the possible benefits of anti-adhesion therapy. This could be the reason for the absence of wide use of such a particular successful therapy. On the other side, it will be far better

to concentrate on simple tissues rather than on complex tissues when developing anti-adhesions . Clear understanding of such adhesions stereochemistry as well as their membrane-ligand interactions will enable for a practical design of anti-adhesive molecules. block several targets through wide specificity inhibitors are indeed a great solution. They demonstrate to be of a great efficient with the current antibiotics.

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