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**MICROBIOLOGICAL EVALUATION OF THE EFFECTIVNESS OF MODERN ANTISEPTICS, ANTIMICROBIAL MATERIALS**

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**Key words: antiseptics,** decasan®, miramistin, chlohexidine, dressings, purulent-inflammatory processes.

Effectiveness of antiseptics (decasan®(DC), chlorhexidine digluconate (CH), miramistin (MR), antimicrobial composition of decamethoxin (AMC, patent N 74853, Ukraine), antimicrobial dressings against isolated strains of *S. aureus* (*n 32*), *E. соli* (n 25), *P. aeruginosa* (n 20), *C. albicans* (n 16) in patients with diabetes having pyo-inflammatory complications has been researched. The antimicrobial properties of antiseptics have been studied by means of the serial dilutions method. The antimicrobial activity of dressings (1.0x1.0 cm), such as medical cotton impregnated with AMC; antiseptic overlay with CH (AOCH); Traumastem Biodress Disinfect® (TBD); activtex CH®, activtex CHF®, against clinical isolates of microorganisms has been studied on solid media. The bactericidal action against *S. aureus* in the presence of AMC (1.4±0.2 мkg/ml), DC (1.73±0.2 мkg/ml); CH (12.8±2.1 мkg/ml); MR (8.3±0.9 мkg/ml) has been found. The bactericidal properties of DC and MR in relation to *E. соli* in their concentrations of 6.68±0.71 and 17.9±1.9 мkg/ml, respectively, have been determined. AMC (4.9±0.5 мkg/ml) was six times more active than CH (р<0.001). The antipseudomonal action of DC against *P. aeruginosa* was 1.5 times higher than CH. AMC had also 2.8 times higher activity (р<0.001). The bactericidal action of MR was registered in the presence of 72.9±2.2 мkg/ml. It has been found that *C. albicans* is sensitive to AMC (7.4±1.9 мkg/ml), DC (14.6±1.9 мkg/ml), MR (26.0 ± 3.6 мkg/ml). CH has a low effectiveness in relation to *C. albicans* (32.8±7.4 мkg/ml). Advantages of the antimicrobial activity of modern antimicrobial dressings with AMC against *S. aureus, E. coli, P. aeruginosa*, fungi of *Candida* genus have been found.

**Introduction.** Infectious complications in the structure of surgical diseases occupy a prominent role up to 35-45% of all surgical illnesses. The special attention is paid to purulent-inflammatory processes in patients with diabetes, who have the syndrome of diabetic foot (SDF). According to international convention of problems of diabetic foot, SDF was defined as infection, ulcer, and/or destruction of deep tissues, associated with neurological dysfunctions, decreasing of central blood stream in arteries of lower extremities of different severity. Despite of the progress in the study of etiology and pathogenesis of purulent-inflammatory processes in the case of SDF, the appearance of numerous conservative and surgical methods treatment, the problem of prophylaxis, treatment of infectious complications is still actual and needs further research of new antimicrobial treatment to be found [4, 6].

The analysis of peculiarities of purulent-inflammatory processes in the case of diabetes has shown that infection of foot wound in patients with diabetes are of polymicrobial associative character. It is known, that strains of *S. aureus* contaminate wounds in cases of SDF as a rule. When chronical purulent-inflammatory processes happen in microorganisms of *Enterobacteriacae* (*E. coli, Proteus spp.*), non-fermentative Gram-negative bacteria (*P. aeruginosa* *Acinetobacter spp.*) and others can be found in wounds. Long lasting antimicrobial therapy of purulent-inflammatory processes leads to recurrent and superinfection. Besides, there are some difficulties of antibiotics’ diffusion into tissues, when SDF happen. Low antibiotics’ concentrations in a wound further the selection of resistant variants of opportunistic microorganisms [1].

The views about the role of antibiotics, antiseptics in treatment of purulent wounds in patients with SDF alter with the appearance of multi-resistant strains of microorganisms to antibiotics. The attempts to investigate new antiseptics are carried out, the development of the use of known remedies. The implementation of topical prophylaxis and treatment of diabetic foot wound infection by means of new antiseptics, dressings [2, 6].

**The aim**. To assess the effectiveness of modern antiseptics, antimicrobial dressings in patients with SDF and purulent-inflammatory complications of wounds.

**Materials and methods**. In the research, we isolated clinical strains of (*S. aureus* (n 32), *E. coli* (n 25), *P. аureginosa* (n 20), *C. albicans* (n 16) from patients with sugar diabetes, having purulent-inflammatory complications of SDF. We studied antimicrobial activity of antiseptics decasan (DS), chlorhexidine digluconate (CHD), miramistin (MR); antimicrobial composition of decamethoxin (AMC) against isolated clinical strains of microorganisms by means of double dilution method [5]. Minimal inhibitory (MIC) and minimal cidal (MCC) concentrations of antiseptics [3].

The research of antimicrobial qualities of medical cotton (medical calico), impregnated with AMC; dressings: antiseptic overlay with chlorhexidine (AOCh), Traumastem Biodress Disinfect® (TBD, Czech Republic, Aprena Company), Activtex® Ch (Russian Federation), Activtex® ChF which contains chlorhexidine digluconate and Furagin (Russian Federation). Antimicrobial activity of test sample of dressings (1,0x1,0 sm) was studied on the dense medium, sown with clinical strains of *S. aureus, E. coli, P. aeuruginosa*, *C. albicans*. Antimicrobial activity was estimated by the absence of microorganisms’ growth around the samples of textile (mm) after 24 hours of thermostat regimen (t 37 °С).

**Results and their discussion**. In the result of the research, there was found high sensitivity of clinical strains of microorganisms, isolated from patients with SDF, complicated with purulent-inflammatory processes, to antiseptics. High antimicrobial activity was found in AMC against clinical strains of *S. aureus*, that was higher than antiseptic activity of miramistin in six times. Bactericidal qualities of this composition was found, when its 1,4±0,22 mkg/ml were used. Effective antimicrobial qualities were found in decasan. Clinical strains of *S. aureus* were sensitive to MCC 1,51±0,14 mkg/ml of the drug. We found that CHD had low antimicrobial qualities against *S. aureus*, which were lower than in antimicrobial composition of decamethoxin and DS in nine and seven times respectively (table 1; р<0,001).

Table 1

**Sensitivity of clinical strains of microorganisms to antiseptics**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Antiseptics** | **Microorganisms (n)** | | | |
| ***S. aureus***  ***(n 32)*** | ***E. coli***  ***(n 25)*** | ***P. aeruginosa (n 20)*** | ***C. albicans***  ***(n 16)*** |
| ***MCC\*, mkg/ml (М ± m)*** | | | | |
| **antimicrobial composition** | 1,4±0,2 | 4,9±0,5 | 39,06±4,1 | 7,4±1,9 |
| **decsan** | 1,73±0,2 | 6,68±0,71 | 79,2±7,4 | 14,6±1,9 |
| ***р\*\*\**** | >0,05 | >0,05 | <0,001 | <0,01 |
| **chlorhexidine digluconate** | 12,8±2,1 | 24,1 ± 3,2 | 109,3 ± 8,2 | 32,8±7,4 |
| ***р\*\*\**** | <0,001 | <0,001 | <0,001 | <0,01 |
| **miramistin** | 8,3±0,9 | 17,9±1,9 | 72,9±2,2 | 26,0 ± 3,6 |
| ***р\*\*\**** | <0,001 | <0,001 | <0,001 | <0,001 |

**\*MCC** –minimal cidal concentration, *\*\** ***р*** – relatively with AMC

The sensitivity of clinical strains of Gram-negative microorganisms, contaminating purulent wounds of patients with SDF, was ambiguous. High antimicrobial qualities of AMC, DS against *E. соli* were proven. AMC demonstrated bactericidal action on *E. соli* in the dose 4,98±0,5 mkg/ml. Decasan was effective against *E. соli* when MCC like 6,68±0,71 mkg/ml were used. Clinical strains of *E. соli* had four times lower sensitivity to chlorhexidine digluconate, than to decasan. Antimicrobial composition had in six times higher activity against *E. соli* than CHD (р<0,001). It was found, that miramistin demonstrated antiseptic activity on *E. соli*, when 17,98±1,87 mkg/ml of the drug were used. Such antimicrobial activity of MR against *E. соli* was three times lower than antimicrobial qualities of decasan and AMC (table 1; р<0,001).

Clinical stains of *P. aeruginosa* were defined to be hardier to the effect of antiseptics in comparison with Staphylococcus and Enterobacteria. There were identified that chlorhexidine digluconate had the less activity on *P. aeruginosa*. The minimum bactericidal concentration for *P. aeruginosa* reached 109,34±8,16 mcg/ml of chlorhexidine digluconate. The antimicrobial effect of decasan® was in 1,5 times higher (MCC 79,2±7,4 mcg/ml), antimicrobial composition provided antipseudomonad effect in 2,8 times better than chlorhexidine digluconate (р<0,001). Miramistin showed antimicrobial activity on *P. aeruginosa* in presence of MCC 72,9±2,2 mcg/ml.

The results of the microbiologic research demonstrate high activity of decasan® and antimicrobial composition on fungi of the genus Candida that cause infectious complications on diabetic foot.

High sensitivity of *C. albicans* clinical stains to antimicrobial composition was determined (MCC 7,4±1,9 mcg/ml). Fungicidal activity of decasan® on *C. albicans* was defined (MCC 14,6±1,9 mcg/ml). Sensitivity of fungi of the genus Candida to miramistin was detected to MCC 26,04±3,6 mcg/ml of antiseptic. Chlorhexidine digluconate possessed low activity on *C. albicans* (MCC 32,81±7,42 mcg/ml).

Dressings and other medical devises with antiseptics are widely used for prophylaxis and treatment of SDF infectious complications. From this point of view it was expediently to investigate *in vitro* antimicrobial effectiveness of modern antimicrobial materials on potential causative microorganisms of purulent-inflammatory processes in patients with SDF. Statistically validly medical cotton impregnated with antimicrobial composition was the most active (35 mm; tab. 2).

Table 2

**Antimicrobial activity of dressings against clinical strains of microorganisms, isolated from patients with SDF**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Antimicrobial dressings** | ***S. aureus***  **(n 32)** | ***E. coli***  **(n 25)** | ***P. aeruginosa* (n 20)** | ***C. albicans***  **(n 16)** |
| ***zone of growth inhibition*, *mm***  **(М±m)** | | | |
| Medical cotton with AMC | 32,4±0,5 | 26,4±0,3 | 20,8±0,34 | 32,0±0,8 |
| Antiseptic overlay with chlorhexidine | 19,4±0,2 | 14,4 ± 0,2 | 11,2±0,2 | 15,0±0,2 |
| Traumastem Biodress Disinfect® | 19,0±0,3 | 14,6 ± 0, 2 | 10,8±0,2 | 14,5±0,3 |
| Activtex® Ch | 21,2± 0,4 | 15,6 ± 0,2 | 15,6±0,2 | 14,3±0,4 |
| Activtex® ChF | 22,0 ± 0,3 | 20,20± 0,2 | 19,2±0,2 | 15,0±0,4 |

The growth inhibition zone of *S. aureus* test-stains around antimicrobial dressings Activetex®Ch; САХ; TBD did not exceed 21,2±0,4 mm. Dressings Activetex ®ChF with chlorhexidine digluconate and furagin inhibited the growth of *S. aureus* on 22 mm.

In comparison with antimicrobial materials with chlorhexidine digluconate the advantage of antimicrobial activity of unbleached calico impregnfted with antimicrodial composition on *E. coli* (growth inhibition zone 26,40±0,32 mm) was obvious. Activetex ®ChFinhibited the growth of *E. coli* on 20,20±2,20 mm.

Unbleached calico impregnfted with antimicrodial composition was testified to have high antimicrobial activity on *P. aeuruginosa* (growth inhibition zone 21,80±0,20 mm). Statistically validly antimicrobial properties of the materials with chlorhexidine digluconateon *P. aeuruginosa* were the worst (р<0,05). Dressings САХ, TBD, Activetex®Ch, possessed low activity on the stains of *P. aeuruginosa*. The zones of growth inhibition around these materials were less than 10,80±0,20 mm. *P. aeuruginosa* was more sensitive to Activetex®ChF (growth inhibition zone 16,2±0,2 mm).

**Conclussions.**

1. Such antiseptics as decasan and antimicrobial composition of decamethoxіn possess strong antimicrobial properties on the causative microorganisms of purulent-inflammatory deseases (*S. aureus, E. coli, P. aeruginosa, C. albicans*). Miramistin has sufficient (but lower in comparison with decasan and antimicrobial composition, р<0,05) antimicrobial effectiveness on the microorganisms that cause infectious complications in SDF. Chlorhexidine digluconate shows low antiseptic effect against *Pseudomonas* (<0,001).
2. The benefit of antimicrobial properties of modern dressings impregnated with decamethoxin on *S. aureus, E. coli, P. aeruginosa*, *C. albicans* was proven.

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