J Infect Chemother
DOI 10.1007/s10156-013-0564-2

ORIGINAL ARTICLE

An algorithm for the management of *Staphylococcus aureus* carriage within patients with recurrent staphylococcal skin infections

Fotios Tzermpos · Theodora Kanni · Vassiliki Tzanetakou · Christos Papadimas · Anastasia Antonopoulou · Athina Savva · Nadia Theologie-Lygidakis · Evangelos J. Giamarellos-Bourboulis

Received: 4 November 2012 / Accepted: 20 January 2013

Abstract Recurrent skin infections of staphylococcal origin raise the question of probable skin colonization by *Staphylococcus aureus* and the need for eradication. Available evidence does not exist for such settings. A management algorithm was developed by a group of experts that was implemented prospectively in 125 patients admitted for recurrent staphylococcal skin infections. Patients were tested for skin carriage of *S. aureus* in seven body surfaces. In the event of carriage, therapy was administered consisting of hair and body washing with antiseptics for 60 days and parallel oral treatment according to the antibiogram for 30 days. Patients were followed up for 3 years. Seventy-nine patients were colonized by *S. aureus*, 49 by methicillin-susceptible (MSSA) and 30 by methicillin-resistant (MRSA) isolates. The eradication rate following the algorithm was 83.7 % for patients colonized by MSSA and 90.0 % for patients colonized by MRSA. The greater eradication rates were achieved after treatment with one antistaphylococcal penicillin or clindamycin in the case of MSSA carriage and with clindamycin or a fluoroquinolone in the case of MRSA carriage. Of the 79 treated cases, 18 relapsed. Time to relapse did not differ between MSSA carriers and MRSA carriers. It is concluded that the suggested algorithm may be clinically efficacious and achieve high decolonization and low relapse within patients with recurrent staphylococcal skin infections colonized by either MSSA or MRSA.

Keywords Skin infections · *Staphylococcus aureus* · Carriage · Treatment algorithm

Introduction

Persistent carriage of *Staphylococcus aureus* takes place in almost 20 % of healthy individuals. However, this may be increased up to 70 % after residency in a hospital or in long-term care facilities and may even lead to recurrent skin infections [1]. A common practice for patients who develop recurrent skin infections is to search for colonization by *S. aureus* and to try to decolonize them. However, the efficacy of this approach is questionable. Available data suggest that people colonized by *S. aureus* benefit from local application of antiseptics, mainly chlorhexidine, in parallel with nasal treatment with mupirocin and a short course of antimicrobials [2, 3]. This therapy usually leads to eradication of staphylococcal carriage in almost 80 % of cases [4]. However, available studies are characterized by heterogeneity in treatment schedule whereas they enroll patients based on diagnosis of staphylococcal carriage. Several times patients present with relapsing staphylococcal skin infections, necessitating answers to two questions: is relapse connected with staphylococcal carriage; and, in case of carriage, are local antiseptics and short courses of antimicrobials sufficient therapy or should antimicrobial treatment be extended?

F. Tzermpos · C. Papadimas · N. Theologie-Lygidakis
Department of Oral and Maxillofacial Surgery, University of Athens, School of Dentistry, Athens, Greece

T. Kanni · V. Tzanetakou · A. Antonopoulou · A. Savva · E. J. Giamarellos-Bourboulis (✉)
4th Department of Internal Medicine, ATTIKON University Hospital, University of Athens, Medical School, 1 Rimini Str, 12462 Athens, Greece
e-mail: egiamarel@med.uoa.gr

E. J. Giamarellos-Bourboulis
Integrated Research and Treatment Center, Center for Sepsis Control and Care, Jena University Hospital, Jena, Germany

Published online: 03 February 2013

Both these answers remain unanswered by available clinical studies.

In an attempt to handle this problem, a management algorithm was developed by a group of experts. The efficacy of this algorithm was prospectively evaluated.

Patients and methods

Study design

The study was conducted during the 6-year period January 2006–January 2012. Study enrollment took place during the first 3 years of this period because a follow-up period of 3 years was necessary for every enrolled patient. The study protocol was approved by the Ethics Committee of the ATTIKON University General Hospital. Patients were enrolled after written informed consent. Only patients under follow-up at the Outpatients Department of Immunology of Infectious Diseases participated in the study.

Patients were screened for enrollment from a pool of patients admitted for follow-up if that they had all the inclusion criteria and none of the exclusion criteria listed below. Inclusion criteria were (a) age ≥18 years; (b) active recurrent staphylococcal skin infections; (c) history of more than three recurrences during the past year; and (d) lack of intake of any antimicrobial in the past 2 months. Microbiological diagnosis of staphylococcal skin infection was based on the isolation of *S. aureus* from pus sampled from the skin lesion according to available definitions [5]. Exclusion criteria were (a) history of hospitalization the past 1 year; (b) history of any surgery involving foreign body implantation; (c) residency in long-term care facilities; (d) history of hemodialysis; (e) concomitant bone infection; (f) pregnancy in the past 2 years; (g) intake of corticosteroids; (h) neutropenia defined as less than 1,000 neutrophils/mm^3; (i) hypoglobulinemia; and (j) chronic renal disease defined as any creatinine clearance less than 80 ml/min.

All patients were followed up, and therapeutic interventions were performed by an algorithm predefined by a group of five experts. E.J.G.B. was the only author participating in this group. The other four experts were independent: two were infectious diseases consultants and two were dermatologists. The algorithm (Fig. 1) was designed to provide a diagnosis for carriage of *S. aureus* and proper management. According to this algorithm, sampling was done using different sterile swabs by seven different skin surfaces, i.e., both nares, both axillae, both femoral folds, and the perianal region. Sampling was performed from all these seven sites provided that none of these sites presented with signs of local inflammation. When signs of inflammation were present, sampling for carriage of *S. aureus* was not done at that site. Swabs were immediately transported and processed as described below.

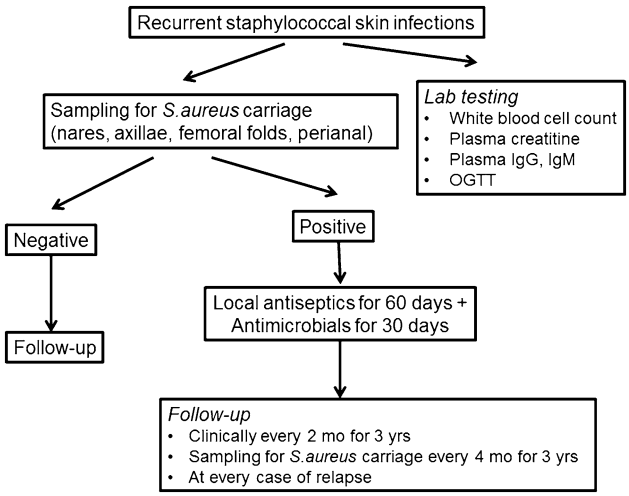

Fig. 1 Designed diagnosis and management algorithm to be used in the present study. *S. aureus Staphylococcus aureus*, *IgG* immunoglobulin G, *IgM* immunoglobulin M, *mo* months, *OGTT* oral glucose tolerance test, *yrs* years

The development of the algorithm was based on the following evidence. (a) The total duration of treatment was 60 days. The usual suggested treatment period for carriers of *S. aureus* consists of oral antimicrobials for 15 days and of local antiseptics for 30 days [2, 3]. However, because the algorithm is aiming to cure patients with recurrent staphylococcal infections, the time of treatment should be prolonged more than usually suggested. As such, a total treatment period of 60 days consisting of antimicrobial treatment for 30 days and of local antiseptics for 60 days was considered appropriate. (b) Longer follow-up than that which is usually suggested is required [6]. To this end, to provide robust findings the total follow-up period was 3 years from the start of therapy per patient.

Carriers of *S. aureus* were assigned to eradication treatment for 60 days. Treatment consisted of washing of body and hair with local chlorhexidine twice daily for 60 days; in addition, antimicrobial treatment was given to each patient based on the antibiogram according to the discretion of the attending physician for 30 days. Every patient could be prescribed only one oral antimicrobial. For carriers of MRSA, physicians were allowed to prescribe either clindamycin or one fluoroquinolone or fusidic acid or trimethoprim/sulfamethoxazole provided that the selected antimicrobial was active on the isolate according to the antibiogram. Carriers of *S. aureus* were then advised to come back for clinical follow-up every other month. In addition, sampling for skin carriage of *S. aureus* was repeated every 4 months. In case of clinical or microbiological relapse, a second treatment course of 60 days was suggested. The total period of follow-up was 3 years for