In October 2004, APUA released the Executive Summary of its landmark report on antimicrobial resistance worldwide, *Shadow Epidemic: The Growing Menace of Drug Resistance*. Produced by APUA’s Global Advisory on Antibiotic Resistance Data (GAARD) project, the report synthesizes AMR data and trends from 15 global surveillance networks. The result is today’s most up-to-date snapshot of drug resistance — a picture that does not bode well for public health. From staph and pneumococcus to HIV and TB, drug resistance is inexorably rising.

*Shadow Epidemic* has sent an alert to policy makers and medical professionals about the enormity of the antimicrobial resistance threat and the mandate for more appropriate antimicrobial use. Above all, the report underscores the need for surveillance — local, national, and global — to track resistance and guide treatment decisions. Around the world, surveillance networks have improved our ability to detect, monitor and manage antimicrobial resistance. Information from coordinated surveillance studies tells us how drug resistance varies geographically and over time. Vigilant monitoring of resistance rates can help target resources efficiently. This rational targeting of resources, in turn, cuts the cost of health care, by preserving the power of current first-line antimicrobials. Investigating why some locales have low resistance rates while others have high rates also offers clues to the underlying causes of drug resistance.

The development and expansion of laboratory systems responsible for surveillance data collection are essential components of the mission to monitor antimicrobial resistance. These facilities not only assist physicians in the proper diagnosis and treatment of infections, but also help disseminate treatment guidelines and strategies.

Large, multi-year studies are also instrumental in tracing the evolution of antimicrobial resistance. Data from these studies can be used to build mathematical models, which are essential in predicting future patterns of resistance. Unfortunately, the number of antimicrobial resistance studies conducted by pharmaceutical companies has declined in recent years. Though these firms continue to support surveillance, the scale and scope of such studies will likely be downsized, reflecting the companies’ preferential interest in chronic disease treatments and lifestyle drugs.

*Shadow Epidemic* recommends supporting national and international surveillance efforts to determine the frequency of resistance to antimicrobials; researching and developing new therapeutic agents with novel modes of action to treat and control resistant infections; establishing infectious disease protocols to promote prudent antimicrobial prescribing and dispensing practices; and improving access to, and use of, high-quality services for diagnosis, infection control, and treatment.

Clearly, no nation and no single surveillance system can stand alone in heading...
Ask the Expert:
How Should Clinicians Control Increasing Resistance in Gram-Negative Infections?

John Quale, M.D., Division of Infectious Diseases, University Hospital of Brooklyn and Kings County Hospital, Brooklyn, NY

Treatment of Pseudomonas aeruginosa, Acinetobacter baumannii, and Klebsiella pneumoniae — established nosocomial pathogens in many major medical centers — has become increasingly difficult because of progressive antimicrobial resistance. Clinicians frequently rely on carbapenem antibiotics to treat serious infections due to multidrug-resistant Gram-negative bacilli. Unfortunately, in some regions carbapenem resistance is rapidly emerging in P. aeruginosa, A. baumannii, and K. pneumoniae.

Carbapenem resistance rates of ~25% for P. aeruginosa have been reported in Latin America, the United States, and Europe. These strains are typically resistant to other classes of antibiotics as well, including fluoroquinolones and aminoglycosides. Carbapenem resistance is usually attributable to a combination of loss of porins, efflux systems, and the chromosomal cephalosporinase. The presence of efficient carbapenem-hydrolyzing-β-lactamases (particularly metallo-β-lactamases) in P. aeruginosa has emerged in the Far East, Europe, and, more recently, the United States. Only the polymyxins have retained consistent activity against multidrug-resistant P. aeruginosa.

In most medical centers, A. baumannii is considered a relatively unusual nosocomial pathogen; it is not included in the National Nosocomial Infections Surveillance (NNIS) reporting system. Yet in certain regions, such as Brazil and New York City, A. baumannii is problematic in hospitals. And while carbapenem antibiotics play a crucial role in the treatment of serious nosocomial infections due to A. baumannii, carbapenem-resistant strains have begun to proliferate. As with P. aeruginosa, the mechanism of carbapenem resistance is usually attributable to loss of porins and increased expression of the chromosomal cephalosporinase. Isolates of A. baumannii carrying efficient carbapenem-hydrolyzing-β-lactamases (class D and metallo-β-lactamases) have also been reported in several regions, including Europe, South America, and Asia (especially the Middle East and Far East).

Extended-spectrum-β-lactamases (ESBLs) are an increasing cause of antibiotic resistance among Enterobacteriaceae, particularly K. pneumoniae. ESBL-producing strains are also frequently resistant to other classes of antibiotics, including aminoglycosides and fluoroquinolones. Carbapenem antibiotics are generally considered the antimicrobial agents of choice for treating serious infections due to ESBL-producing K. pneumoniae. Isolates of K. pneumoniae carrying carbapenem-hydrolyzing enzymes (especially the class A KPC-β-lactamase) have been increasingly reported, particularly in the New York City area.

Therapy of infections due to carbapenem-resistant P. aeruginosa, A. baumannii, and K. pneumoniae is exceedingly difficult. As noted, many of these isolates are resistant to other classes of antibiotics, including fluoroquinolones and aminoglycosides. For multidrug-resistant P. aeruginosa, polymyxin B (or colistin) is frequently relied upon to treat serious infections. Although clinical experience
is quite limited, clinical outcome with polymyxin therapy for bacteremias and urinary tract infections appears favorable. Carbapenem-resistant isolates of A. baumannii are occasionally susceptible to ampicillin-sulbactam and aminoglycosides (e.g., tobramycin and amikacin). While clinical studies demonstrating the efficacy of ampicillin-sulbactam have been reported, the minimum inhibitory concentrations (MICs) for susceptible isolates approach the breakpoint value. Therefore, this agent should be used with caution to treat serious infections. As with P. aeruginosa, the polymyxins are often called upon to treat serious infections due to multidrug-resistant A. baumannii. Again, while clinical experience is limited, preliminary data appear to demonstrate clinical efficacy of polymyxins for many infections. Several studies have demonstrated additive or synergistic effects in vitro when polymyxin B is used with various combinations of rifampin, azithromycin, and/or imipenem. Whether these combinations translate into improved efficacy or reduced toxicity remains to be seen.

Therapeutic options for KPC-possessing K. pneumoniae are extremely limited. Occasional isolates are reported susceptible to cefotetan and/or cefepime. However, as with isolates carrying ESBLs, these agents should be used with caution, because their MICs approach breakpoint concentrations. Many KPC-possessing isolates have the rather unusual susceptibility pattern of being resistant to all agents except gentamicin and tetracycline. Although the tetracycline MICs approach the breakpoint for susceptibility, most isolates are susceptible to the investigational glycyclycline, tigecycline. The clinical effectiveness of this agent remains to be determined. Polymyxin B is often the agent of last resort for the treatment of carbapenem-resistant K. pneumoniae; however, polymyxin-resistant isolates have also been recovered. Because of the recent emergence of these highly resistant pathogens, clinical experience in their therapy is extremely limited, and firm recommendations are lacking.

Antimicrobial resistance in nosocomial pathogens is associated with both an economic burden and a poorer clinical outcome. With therapeutic options limited, controlling the spread of multidrug-resistant P. aeruginosa, A. baumannii, and K. pneumoniae is crucial. In New York City, outbreaks with these pathogens tend to involve only a small number of strains; aggressive infection control protocols will therefore be paramount. Interrupting transmission will require protocols that include surveillance studies, environmental cleaning, rapid identification and isolation of infected/colonized patients, and improved compliance of healthcare workers to hand hygiene practices. Because these bacteria display a distinct survival advantage in environments where a variety of broad-spectrum agents are administered, controlling the global use of different classes of antibiotics will be critical in slowing the transmission and evolution of drug resistance.

**Susceptibility Data for KPC-possessing K. pneumoniae (n=97)**

<table>
<thead>
<tr>
<th>Antibiotic</th>
<th>Susceptibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Piperacillin-tazobactam</td>
<td>0%</td>
</tr>
<tr>
<td>Cefotetan</td>
<td>60%</td>
</tr>
<tr>
<td>Cefazidime</td>
<td>0%</td>
</tr>
<tr>
<td>Cefepime</td>
<td>40%</td>
</tr>
<tr>
<td>Chloramphenicol</td>
<td>7%</td>
</tr>
<tr>
<td>Ciprofloxacin</td>
<td>2%</td>
</tr>
<tr>
<td>Fosphenyloxacin</td>
<td>2%</td>
</tr>
<tr>
<td>Doxycycline</td>
<td>64%</td>
</tr>
<tr>
<td>Gentamicin</td>
<td>60%</td>
</tr>
<tr>
<td>Tobramycin</td>
<td>3%</td>
</tr>
<tr>
<td>Amikacin</td>
<td>45%</td>
</tr>
<tr>
<td>Polymyxin B</td>
<td>99%</td>
</tr>
</tbody>
</table>

With therapeutic options limited, controlling the spread of multidrug-resistant P. aeruginosa, A. baumannii, and K. pneumoniae is crucial.
off antimicrobial resistance. As economic globalization has proven, all of our lives are interconnected. Infectious disease agents — including drug-resistant organisms — need no visas. They can cross borders with ease, quickly transforming a local outbreak into a global scourge. In this sense, the division between the “industrialized” and “developing” world has disappeared. If world leaders continue to ignore this crisis, the long shadow of antimicrobial resistance will eclipse the best efforts of public health everywhere.

Select Findings from Shadow Epidemic:

*S. pneumoniae*: Global penicillin resistance rates for *S. pneumoniae* range from 5.8% (Canada) to 54% (Hong Kong). Macrolide resistance rates for *S. pneumoniae* range from 11.1% (Canada) to approximately 72% (Hong Kong and Japan).

*H. influenzae*: Resistance to ampicillin ranges from 6% to 43%, depending on the locale. Evidence suggests that *H. influenzae* resistance patterns in the community may mimic those found in *S. pneumoniae*.

**HIV/AIDS**: According to data collected from 1996-2002 in 17 European nations, HIV exhibited resistance rates of 9.6% to any drug class, and upwards of 1.7% to two or more drug classes. There are currently no reliable estimates of HIV resistance globally.

**Malaria**: The emergence and spread of parasites resistant to drug treatment has increased malaria morbidity and mortality. New drugs with novel chemical structures and modes of action, as well as combination therapies, are critical.

**Tuberculosis**: Multidrug-resistant TB has reached alarming and unprecedented levels in every corner of the globe. High concentrations are found in East Europe, nations of the former Soviet Union, certain provinces of China, and Ecuador. Strengthened laboratory networks and surveillance are essential in TB control.

**Gonorrhea**: Traditional antimicrobials such as penicillins and tetracyclines, as well as newer quinolone drugs, are increasingly ineffective in treating gonorrhea. The usefulness of new macrolides and spectinomycin is also limited. The Western Pacific Region has seen rates of quinolone-resistant strains of gonorrhea exceeding 50%, rendering quinolone therapy totally ineffective in some areas.

**MRSA**: Community-acquired methicillin-resistant *Staphylococcus aureus* (CA-MRSA) is rising. The organisms have been described in several well-defined populations, including children, incarcerated persons, Alaska Natives, Native Americans, Pacific Islanders, sports participants, and military personnel.

Maryland. Brachman, a former director of the U.S. Centers for Disease Control and Prevention’s Epidemic Intelligence Service, began his career in the 1950s focusing on anthrax in textile mills, and went on to exhaustively study the organism.

**Q**: Are new antibiotics necessarily the answer for weaponized pathogens?

**GKG**: Even when it’s possible to use antibiotics, they don’t always work. Some of the 2001 anthrax victims in the U.S. who died did receive antibiotics, but because of the toxin levels and advanced state of disease, the antibiotics couldn’t save them. Other therapies are still needed — even for bacteria that are not antibiotic-resistant. In general, you can’t rely on one therapeutic approach, particularly for pathogens that are likely weapons. Beyond the likely weapons, you also need to develop the capability to respond, no matter what the disease.

**Q**: How easy is it to engineer antimicrobial resistance?

“One of the advantages of looking at other forms of immunity, or other ways to create immunity, would be the broad application to infectious disease in general, not just bioterrorism.”

— Philip Brachman, M.D.

**GKG**: It is pretty straightforward, unfortunately. It’s not something you can do without any training, but on the other hand it’s not that difficult. The materials are not inaccessible. The knowledge is not inaccessible. In a lot of the papers that have been published about antibiotic resistance, the researchers didn’t use molecular biological techniques. They just put a little of the antibiotic into the growth media and allowed evolution to take effect. The bacteria naturally acquired resistance.

**Q**: You’ve pointed out that some scientists generate antibiotic-resistant bacteria to determine how bacterial strains can become drug-resistant — that’s how researchers discovered that Bacillus anthracis can produce beta-lactamases (which, in turn,
**REPORT FROM THE FIELD**

### Assessing the Prevalence of Vancomycin-Resistant Enterococci (VRE) in Lebanese Hospitals

Ziad Daoud*, Ph.D., Saint George University Hospital and University of Balamand; Carole Ayoub, Ph.D. (under preparation), Faculté de Pharmacie, Université Paris 5; Jacques Mokhbat, M.D., Rizk Hospital and Lebanese University; Noha Hakimé, M.D., Saint George University Hospital and University of Balamand; Flavence Doucet-Populaire, Ph.D., Faculté de Pharmacie, Université Paris 5; Raymond Rohban, M.D., Saint Joseph Hospital; Monzer Hamzé, Ph.D., Nini Hospital and Lebanese University; Hiyam Matta, M.D., Arz Hospital

* APUA-Lebanon Chapter Coordinator

Enterococci have emerged worldwide as alarming nosocomial pathogens, in part because of their intrinsic and acquired resistance to many antimicrobial agents, most recently vancomycin. In Lebanon, a 12-month, prospective, multicenter point-prevalence study evaluated the epidemiology of VRE carriage and occurrence in hospitalized patients. The objectives of the study were to:

- assess the prevalence of colonization with VRE
- discover if VRE is endemic
- identify factors that predispose to VRE
- determine the phenotypes and genotypes of enterococcal resistance to antibiotics
- evaluate the intra- and inter-species transferability of resistance genes

The study involved the intensive care units of five Lebanese tertiary care general hospitals (Saint George Hospital, Rizk Hospital, Nini Hospital, Arz Hospital, and Saint Joseph Hospital). Over three months, 1,500 fecal samples were collected. Recovery of suspected VRE from these samples and antibiotic susceptibility testing were performed in each participating hospital’s microbiology laboratory; the suspect strains were sent to the collecting laboratory at Saint George Hospital for molecular analysis in Paris (Faculté de Pharmacie, Paris V).

**Results:** MICs of vancomycin and teicoplanin, as well as identification by the Multiplex-Polymerase Chain Reactions, were performed on the suspected isolates for species identification and detection of the different genes encoding resistance to vancomycin (vanA, vanB, vanC). Among all the rectal swabs performed during the period of this study, no VREs were confirmed. Identification of VRE by means of surveillance cultures revealed that colonization by that type of multidrug-resistant strain didn’t exist during the duration of the study. This demonstrates the low occurrence of the resistant bacterium in healthy carriage among the Lebanese population. Only one *E. faecium* harboring the vanA gene was isolated previously from a patient with infective endocarditis.

The absence of VRE colonization in hospitalized patients in Lebanon should reassure health professionals about the efficacy of current antibiotic prescription, and may reflect sound management of patients in ICUs.

---

**ONE-on-TWO continued from page 4**

*is why penicillin was not prescribed in the aftermath of the 2001 anthrax attacks). Antibiotic resistance is also employed as a molecular biology tool — a marker — to select for bacteria that have taken up plasmids. Do these routine practices worry you?*

**GKG:** It’s a technique. But almost always, you’re not supposed to use antibiotics that have clinical relevance in humans, and if you do, you are supposed to get special permission from the institutional recombinant advisory committee (RAC). So in a laboratory, if you’re doing normal experiments and using antibiotics that bacteria don’t like, you’re not going to engineer an organism for which there are no antibiotics.

**Q:** But bioweaponeers could maliciously use the same process?

**GKG:** They would have to adapt it for their purposes. They don’t sell bioweaponeering tools in a kit.

**Q:** You’ve written about the openness and accessibility of modern research. Yet you’re also cautioned about the Persephone Effect: the notion that important discoveries can be captured and used for malicious intentions. How do we protect ourselves against that?**

**GKG:** We all want scientists to do safe science. We also want them to be aware of the risks in their own work — or at least give a thoughtful pause to their work and practices so that they can consider how their work could be misused. Beyond that, I don’t support the idea of regulating each and every project beyond the institutional level.

A lot of this research is dual use: Discovering mechanisms of pathogenicity and how the anthrax toxin, for example, exploits the human immune system: the more you find out about that, the more you understand how the human immune system responds to other agents. You also learn how you can make that disease potentially worse. Biological research is so translational. You can make an ethical argument that we have to go ahead with an experiment, if the potential benefit...
**ONE-on-TWO continued from page 5**

equals the potential downside. You can make a case that it could have a potential downside — but it could have a strong potential upside: You can learn how humans respond to disease and how you can strengthen that response.

**Q:** During and after the SARS epidemic, there were three biosafety accidents where researchers came down with infection. Does that worry you?

**GKW:** That’s really troubling. It might not be bioterrorism that gets us — it probably will be a laboratory accident. On the positive side, this is something that we can prepare for. Biosafety, and safe handling of infectious microbes, are things that need to be taken more seriously.

**Q:** During a bioterrorism outbreak, how can we best coordinate the efforts of scientists and public health experts?

**GKG:** Whether it’s a drug-resistant pathogen or a new infection or an old infection, we know we will have questions to which we will need answers. There are “known unknowns.” For a drug-resistant anthrax or plague, first of all you need to figure out if it is drug-resistant. That’s going to require testing. Then there are going to be drugs that are readily available that need to be tested against that. These have to be identified. There are public health questions: How can you prevent transmission? Is a mask enough? How can it be worked with safely in the laboratory? Can you develop a vaccine for it? A lot of research endeavors have to occur at once, in a time of crisis. We need to pay more attention to how that can be coordinated and how you get the right experts to the table.

Scientists typically don’t have to operate on the same real-time schedule as first responders and public health workers. But this needs to change. The CDC can’t do it alone — no matter how many experts they have, they can never have the range of expertise that the whole scientific community has. I worry that in a time of crisis, the right scientific experts won’t even be there, because the people who are coordinating the response might not know that they need them. There needs to be a mechanism for scientists to volunteer their services. That’s tricky — it requires a lot more openness and it requires planning before an epidemic.

***

**Q:** How quickly could researchers discern an antibiotic-resistant anthrax from a normal strain?

**PB:** The most rapid way would be to take it into the laboratory and streak it out on antibiotic media and see if it grew or not, or do your disk sensitivities or tube dilution sensitivities. We’re talking about something that should take one day. You wouldn’t have to wait clinically, which might take two or three or four or five days, to see if people got better.

**Q:** If the organism is determined to be antibiotic-resistant, what is the public health challenge?

**PB:** You have to find a drug to which it is not resistant. Admittedly, sometimes when the laboratory says a strain is drug-resistant, if you give that drug or give it in large doses, sometimes there is a clinical impact and it works out OK.

**Q:** Still, would we need to scale up production of the drug to which the organism was sensitive?

**PB:** If there’s a production line making that drug all the time, maybe they run it 24 hours a day. Can you start a new production line? That takes a long time. Secondly, unless FDA would relax rules and regulation, you would have to go through testing to make sure it was pure, a proper dose, etc. In a real emergency, I think FDA would curtail some of these rules to get something out rather rapidly.

**Q:** Would we need to ration antibiotics?

**PB:** I suppose. But how do you ration? Who gets the drug if it’s in short supply? Do you give it to your military and police? Do you give it to the first-line responders? That becomes very difficult.

**Q:** We read about antibiotic-resistant anthrax. But the Soviet bioweapons program reportedly made a strain of plague resistant to 16 antibiotics. Do you worry about plague?

**PB:** Pneumonic plague is something that can be treated with antibiotics under normal circumstances. If you have a drug-resistant strain, then you’ve got problems. For one thing, the plague vaccine is not readily available; they make it for laboratorians, but it’s not used for civilians. Second, pneumonic plague can go from human to human.

**Q:** Should we invest more on research into other non-antibiotic approaches to defending ourselves against disease? Should we look into boosting innate immunity?

**PB:** One of the advantages of looking at other forms of immunity, or other ways to create immunity, would be the broad application to infectious disease in general, not just bioterrorism. That is one of the benefits — if one can speak of a benefit — of our efforts against bioterrorism.

---

“We all want scientists to do safe science. We also want them to be aware of the risks in their work.”
— Gigi Kwik Grönvall, Ph.D.

---

Drs. Grönvall and Brachman spoke with Associate Editor Madeline Drexler.
APUA News

GAARD


APUA coordinated a well-attended focus session at ICAAC, “Antimicrobial Resistance Information Systems: Lessons Learned from GAARD and EARSS.” APUA Vice President Dr. Thomas O’Brien served as moderator, while Dr. John Stelling and APUA President Dr. Stuart B. Levy served as presenters. Dr. Stelling delivered a thought-provoking presentation on the impact of AMR surveillance on policy and practice in the European Union, and the utility of AMR surveillance systems in the developing world. Dr. Levy highlighted the GAARD Network’s coordinated global AMR data collection.

GAARD held a meeting on November 1, 2004 in Washington, D.C. at ICAAC. Participants represented AMR surveillance systems from Glaxo-SmithKline (Alexander Network), The Jones Group (SENTRY), Bayer AG, the U.S. Centers for Disease Control and Prevention, and the WHO Collaborating Centre on Antimicrobial Resistance.

Schmunis receives Annual Leadership Award

APUA held its Annual Leadership Awards and Member Reception at ICAAC on October 31, 2004. Dr. Gabriel Schmunis, of the Pan American Health Organization, received the 2004 APUA Leadership Award for his long-standing work in promoting an antimicrobial resistance management program throughout Latin America.

APUA International

Argentina

Dr. Aníbal Sosa, APUA International Program Director, and Madeline Drexler, APUA Newsletter Associate Editor, produced a training guide for journalists reporting on antimicrobial resistance for the Voice of America (VOA). In Buenos Aires, Argentina, in October, 2004, Dr. Sosa spoke about the challenges of working with scientists to an audience of health journalists at a VOA-organized event.

APUA-Georgia

APUA-Georgia held its first International Conference on Antimicrobial Resistance and Antimicrobial Therapy on December 6, 2004, in Tbilisi, Georgia. APUA Vice President Thomas O’Brien gave a presentation on the “Emergence, Spread and Control of Antimicrobial Resistance.” Other presentations included Resistance of Main Hospital Pathogens in Georgia (Paata Imnadze, National Disease Control Center); Multidrug-Resistant Tuberculosis (George Chechinashvili, National Center of Lung Diseases and Tuberculosis); Community-Acquired and Hospital Pneumonia: Resistance and Treatment (Alexander Nanuashvili, APUA-Georgia Chapter Coordinator).

Europe

Dr. Aníbal Sosa attended the Antibiotic Resistance Prevention and Control (ARPAC) Consensus Conference on November 22-24, 2004. Sponsored by the European Society of Clinical Microbiology and Infectious Diseases (ESCMID) and the Dutch Working party on Antibiotic Policies (SWAB), the conference aimed to lay the foundations for a better understanding of the emergence and epidemiology of antibiotic resistance in human pathogens, and to evaluate and harmonize strategies for prevention and control of antibiotic-resistant pathogens in European hospitals. Conference proceedings are posted online at: http://www.abdn.ac.uk/arpac/.

For more information about upcoming chapter events, visit: http://www.tufts.edu/med/apua/intl/events.html. To submit an event to be included on the page, email Flora Traub, International Program Coordinator, at flora.traub@tufts.edu. Please include: type of event and title, date, location, host chapter, and contact.
Alliance for the Prudent Use of Antibiotics
75 Kneeland Street
Boston, MA 02111 U.S.A.

If you are concerned about the public health threat of antibiotic resistance, become part of the solution. Make a tax-deductible contribution and join our global network of citizens, clinicians, researchers and policy makers.

Name ________________________________________________________
Address ________________________________________________________

________________________________________________________
________________________________________________________
________________________________________________________

Areas of Interest ________________________________________________________

Telephone ____________________ E-mail Address _________________________

Payment method is in US dollars (please check one):
☑ Check drawn on a US affiliate or international money order, payable to APUA
☑ Mastercard ☑ Visa

Card Number
Expiration Date
Signature

*Membership is complimentary in the developing world.

APUA is a 501(c)(3) nonprofit, donations are US tax-deductible.

**Supporting memberships sponsor members in a developing country.

Founded in 1981 as a nonprofit organization, APUA is the only organization in the world solely dedicated to strengthening society’s defenses against infectious diseases through research and education on antibiotic use and antibiotic resistance. APUA’s mission is to improve infectious disease treatment and control worldwide through promoting appropriate antibiotic access and use and reducing antibiotic resistance. With members in over 100 countries and numerous foreign affiliated chapters, APUA provides a unique network to support country-based activities and facilitate international planning and communication. APUA’s resources include an international scientific advisory board with members of national academies of medicine and science and a professional staff with specialized expertise. APUA’s global network of affiliated chapters serves to tailor interventions to local customs and practices.

• APUA COUNTRY CHAPTERS: Argentina, Australia, Bangladesh, Belarus, Bolivia, Brazil, Bulgaria, Chile, China, Colombia, Costa Rica, Croatia, Cuba, Dominican Republic, Ecuador, El Salvador, Fiji Islands, Georgia, Greece, Guatemala, India, Italy, Kazakhstan, Kenya, Lebanon, Mexico, Moldova, Nepal, Nicaragua, Nigeria, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Russia, Senegal, Serbia and Montenegro, South Korea, Spain, Sweden, Taiwan, Turkey, Ukraine, United Kingdom, Uruguay, Venezuela, Vietnam, Zambia

• CHAPTERS IN DEVELOPMENT: Botswana, The Gambia, Namibia, South Africa, Tanzania, Uganda

APUA, 75 Kneeland Street, Boston, MA 02111-1901, USA • Telephone: 617-636-0966 • Fax: 617-636-3999 • www.APUA.org... containing global antibiotic resistance through local action