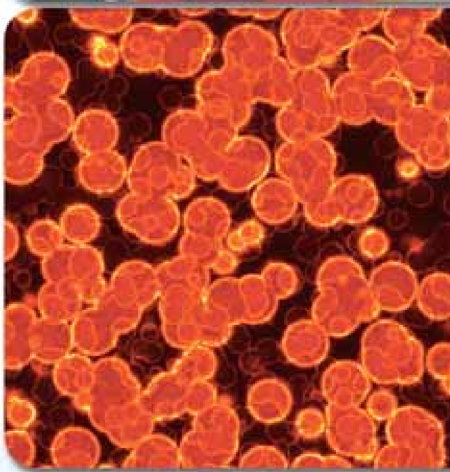
MOH/S/IMR/48.08(GU)

Malaysian Antimicrobial Resistance Surveillance System (MARSS)



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These guidelines have been developed, where possible, by achieving consensus between practising clinicians. The recommendations contained in these guidelines do not indicate an exclusive course of action, or serve as a standard of medical care. Variations, taking individual circumstances into account, may be appropriate.

The authors of these guidelines have made considerable efforts to ensure the information upon which they are based is accurate and up to date. The authors accept no responsibility for any inaccuracies, information perceived as misleading, or the success of any treatment regimen detailed in the guidelines.

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Institute for Medical Research
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Ministry of Health Malaysia

2008

CONTENTS

1. INTRODUCTION

Antimicrobial resistance is a public health threat which increasingly costs lives, prolongs suffering, and squanders limited health-care resources. Surveillance data are required in the development of strategies to contain resistance and to measure the impact of interventions. National surveillance programmes should provide geographically and demographically relevant data on disease aetiologies and resistance trends of key pathogens; alerts of new and emerging resistance threats, including the prompt notification of outbreaks; and guidance in the use of surveillance data for public health action.

Laboratories are one of the important sources of communicable disease data. The importance of the information captured in these facilities might not be perceived significant as sometimes epidemiological information is not available at this point. However, their data could be used to monitor the trend of pathogens detected or isolated in these facilities, as part of early warning systems.

Some laboratories in government hospitals in Malaysia have their own stand-alone system for data collection; but many hospitals do not have any particular system. The system used in an individual facility may not be compatible to the system used by another facility; and sometimes not comparable as they have different variables.

The World Health Organisation (WHO) Global Strategy for Containment of Antimicrobial Resistance recommends the establishment of a national inter-sectoral task force with broad membership for coordinating surveillance activities and overseeing policy interventions and advocacy efforts. Surveillance programmes should provide data to the task force or a designated surveillance subcommittee on local disease patterns, resistance trends, and antimicrobial use practices.

As resistant microorganisms cause a diverse set of clinical and epidemiological challenges, a single surveillance programme generally will not have the technical expertise, time, and resources to address all needed therapeutic, disease control, and research issues. In practice, this is often best accomplished by a “network of networks”. In establishing a plan for resistance surveillance, the national task force should indicate areas of policy and scientific needs in surveillance, identify existing surveillance resources in the country, and prioritise gaps where additional activities are required. Successful coordinators of such programmes have included national public health and reference laboratories, public hospitals, national and international professional societies, and pharmaceutical and diagnostic industry groups, among others. There is thus an important opportunity for the national task force to benefit from the experience, resources, and dedication of existing surveillance groups in formulating and implementing a national surveillance plan.

The Malaysian Antimicrobial Resistance Surveillance System (MARSS) will incorporate collaborations with a number of complementary surveillance groups with distinct priorities, objectives, and organisations. The design of the surveillance programme reflects identified scientific and public health objectives and the availability of resources and expertise, both in the short- and long-term.

2. GENERAL OBJECTIVE

To provide information necessary to secure an approach to the management of communicable diseases that minimises morbidity and mortality whilst also containing the emergence of pathogens resistant to antimicrobials.

2.1. Specific objectives

The objectives of MARSS are:

- To develop a database on antimicrobial resistance and its epidemiology.
- To identify, characterise, investigate and respond to new antimicrobial resistance, including alerts of community and hospital outbreaks; ongoing communication with laboratory staff, clinicians, and public health authorities; and continued re-evaluation of diagnostic test methods and practices.
- To guide clinicians and policy makers on patient management, choice of antibiotic, direct infection

control interventions; and monitor the impact on practice of policies and regulations.

- To strengthen laboratory capability and capacity for the diagnosis and control of communicable disease.
- To establish national and international networking on technical collaboration on antimicrobial surveillance system.
- To develop database on antibiotic usage. This includes determination of define daily dose of each antibiotic and cost effectiveness.

2.2 Scope of MARSS

The MARSS will focus on pathogens of greatest public health importance that are readily transmissible. The surveillance is focusing at providing information on antibiotic resistance trends and development at local and national levels, and giving suggestions on containment strategies.

3. STRATEGIES

Three strategies for ongoing surveillance which may be adopted by a national network include:

- Alert organism surveillance.
- Enhanced surveillance of routine clinical specimens.
- Targeted surveillance and special surveys.

The strategies are complementary; hence the national surveillance network will frequently combine elements of more than one approach into the network organisation. For a start, the MARSS will adopt the alert organism surveillance and enhanced surveillance of routine clinical specimens.

3.1. Alert organism surveillance

In the course of routine laboratory work, microbiology staff occasionally come across strains with unexpected or noteworthy findings of public health importance. Phenotypes may be identified as "unusual" on the basis of their rarity worldwide – vancomycin-resistant *Staphylococcus aureus*, fluoroquinolone-resistant *Salmonella* Typhi, penicillin-resistant Group A beta-hemolytic streptococci – or on the basis of local or national experience – vancomycin-resistant *Enterococcus*, and ESBL producers. The noteworthy finding may be correct or possibly may be attributable to a laboratory error.

An alert surveillance programme is of great value in improving the general quality of laboratory testing by network participants. The experience of several programmes has demonstrated that many phenotypes reported for confirmation are in fact incorrect, and can be attributed to laboratory errors in organism identification or susceptibility testing. Specific deficiencies in test performance or reagent quality may suggest the need for review of diagnostic difficulties through individualised feedback to laboratories, national training activities, or the network quality assurance programme.

An alert organism system is also of great value in documenting the presence of certain resistance phenotypes in a country. However, such programmes do not provide estimates of the strain, and therefore have limited value in guiding antibiotic policy. The discovery of certain findings, e.g. vancomycin-resistant *S. aureus*, may prompt further studies, for example active screening of contacts for carriage or investigations of risk factors for resistance.

3.2. Enhanced surveillance of routine clinical isolates

Specimens processed by participating laboratories, and finalised results are periodically forwarded on to the national coordinators for data analysis and interpretation.

This approach has a number of advantages for purposes of national surveillance: relatively low cost and good sustainability, clinical population-based, broad scope of changing resistance issues, alert of new problems, wide geographic and demographic representation, strengthening of laboratory capacities, etc. An important application of analyses of routine data is guiding infection control interventions through the early identification of outbreaks and problem pathogens.

3.3. Targeted surveillance and special studies

In a targeted surveillance initiative, coordinators develop protocols which go beyond routine practice.

Examples: study on vancomycin-intermediate *S. aureus* and DNA fingerprinting of methicilin-resistant *S. aureus* (MRSA).

A well-designed targeted surveillance programme provides an opportunity to elicit specific responses to priority questions of clinical, epidemiological, or scientific importance such as establishment of standard treatment guidelines; evaluation of risk factors for resistance, transmission, and death; molecular characterisation of clonal populations, etc. However targeted surveillance programmes are usually resource- and labor-intensive, thus compromising long-term sustainability.

4. NETWORK OF ORGANISATION IN THE MINISTRY OF HEALTH (APPENDIX 1)

- Disease Control Division
- National Public Health Laboratory
- Medical Development Division
- Government Hospitals
- Institute for Medical Research
- Information Technology and Communication Division
- Telehealth Division

4.1. Network organisation

MARSS will be coordinated by a central coordinator which will also be the reference laboratory. The central coordinator collects a combination of clinical specimens, laboratory isolates, and/or test results from participating institutions. The surveillance strategy or strategies adopted by the network and specific responsibilities of the participating institutions – for specimen collection, processing and testing, data management – must reflect the resources and capacity at each level.

4.1.1 Role of the reference laboratory

If resources or laboratory capabilities do not permit the required testing to be done at peripheral laboratories, centralised testing by a reference laboratory or other designated institution may be needed. Potential benefits of centralised testing include: a high degree of microbiological data quality; prompt access to advanced microbiological, epidemiological, and informatics expertise with up-to-date knowledge of emerging resistance problems and diagnostic issues; direct control of microbiological methods by standardised protocols; and simplified data management.

Centralised testing does require funds for timely shipment of clinical specimens (if no laboratory processing is done at the peripheral level) or of clinical isolates (if preliminary isolation and identification of organisms is done by peripheral laboratories).

Specimens and isolates are sent to reference laboratories for a variety of reasons which should be distinguished:

- Routine collections: Some reference laboratories do provide ongoing, routine testing of clinical samples and isolates, for example of organisms requiring specialised microbiological techniques such as serotyping of *Salmonella*.
- "Unusual" or "difficult" strains: As part of their ongoing work, reference laboratories often receive a variety of strains for confirmation (imipenem-resistant *E. coli*, penicillin-resistant *N. meningitidis*) or further characterisation [speciation of non-fermenting Gram-negative bacilli, pulsed-field gel electrophoresis (PFGE) of outbreak-associated strains]. These activities are often of great interest as an alert of confirmed resistance phenotypes and suggest areas of further investigation and education.
- Targeted surveillance or time-limited surveys: In addition their ongoing work, many reference laboratories periodically organise targeted research-oriented studies. Targeted studies can be of great value in guiding specific national strategies and policies for resistance containment and clinical therapy.

4.1.2 Identification of laboratories

In establishing a national surveillance programme, the network coordinator should strive for wide geographic and demographic representation. To achieve geographic balance, the network should consist of all major hospitals (Ministry of Health and Ministry of

Education). To investigate the public health impact of antimicrobial resistance in bacterial populations of animals on human populations, coordinators should also consider the inclusion of food and veterinary laboratories in the surveillance programme. Additional criteria for laboratory selection would include laboratory capability and, most importantly, the enthusiasm and motivation of laboratory personnel for participation in the national programme.

4.1.3 Laboratory recruitment

After identifying suitable laboratories, the network coordinator should develop a process for recruitment of laboratories into the network. This may include an initial site visit and evaluation of the laboratory capacity, enrolment in the network quality assurance programme, and a questionnaire on contact details, institution characteristics, and laboratory practices. The objectives and organisation of the network; expectations and responsibilities of network participants and of the coordinating institution are outlined clearly.

4.1.4 Laboratory activities

To enhance the capability of laboratories to provide reliable data both for surveillance and for routine clinical purposes, procedures and criteria for specimen collection, processing, and shipment should be reviewed with laboratory and clinical staff.

While the focus of the network coordinator may be elucidation of a national picture of resistance epidemiology, it must be borne in mind that the most important interventions for containment of resistance must be implemented at the local level – improving diagnostic care, early identification and control of outbreaks, and guiding antimicrobial therapy decisions. Consequently, the local analysis and use of results should be strongly encouraged in educational activities and network discussions. A major responsibility of the network coordinator is provision of timely and relevant feedback to participating institutions on laboratory practices and difficulties and important resistance findings.

Additional laboratory-oriented activities can add considerable value to the surveillance collaboration. Such activities could include periodic site visits, national training programmes and an annual meeting of network participants. The annual meeting provides a forum for collegial discussion among participants on network objectives and activities, resistance and quality assurance results, diagnostic methods, research activities, and future directions. It is also an opportunity to invite relevant national authorities, liaisons with academic and clinical societies, and representatives of local diagnostic and pharmaceutical industries.

5. DATA MANAGEMENT (APPENDIX 2)

The surveillance programme requires a practical strategy for timely management of data submitted by participating laboratories. Steps to be considered are: data collection, analysis and interpretation, and laboratory feedback. Network participants must also agree on issues of data ownership, confidentiality, and data use.

5.1. Data collection

Network coordinators and participants had agreed on the laboratory configuration and minimum number of antibiotics to be tested (Appendix 3) to be included in the surveillance programme. All data should be transmitted to the coordinating institution in the form of raw data.

Organisms and specimens: A comprehensive surveillance strategy typically collects results from a broad range of specimen types and microorganism species. The surveillance collecting data on all cultures positive for any bacterial microorganism with susceptibility test results.

Targeted surveillance is focusing on bacteria with rare resistance pattern (Appendix 4).

Data elements: In routine surveillance programmes network participants are required to collect a minimum set of data elements as stated in laboratory configuration together with antibiogram. Collection of more extensive information on patient or microbiological details may be required for targeted surveillance protocols. Examples of data elements to consider include:

- Patient information: identification number, age or date of birth, sex, location, medical service, admission date, diagnosis, antimicrobial therapy

- Specimen information: identification number, specimen date, specimen type
- Microbiological results: organism identification, antimicrobial susceptibility test results, serotype. Where feasible, quantitative susceptibility test results (mm in disk diffusion or μg/ml in minimum inhibitory concentration [MIC] testing) should be provided.

Data recording: Data are generally recorded on paper forms or in electronic files. For small numbers of isolates, for example in a targeted surveillance initiative, customised data entry sheets may be reasonable. As the number of isolates grows, however, electronic solutions are generally more satisfactory for timeliness and completeness of reporting in the long-term. Data may be recorded in standard desktop applications, such as Microsoft Excel or Microsoft Access; specialised data management protocols, such as WHONET.

WHONET has proved to be a useful software for the local and national management of antimicrobial susceptibility test results, and is available free of charge by download from the web site of the WHO (http://www.who.int/drugresistance/whonetsoftware/en). For laboratories with data in another system (such as Microsoft Excel or Access; a complete laboratory information system; or a laboratory test instrument such as Vitek or Microscan), the BacLink software can usually be used to transfer the existing data sources into WHONET. BacLink is distributed for free as part of the WHONET package.

Data transmission: Submission of data to the coordinating institution should occur at set intervals. Data may be transmitted physically on paper forms, diskettes, or CD or across the internet as e-mail attachments. The network data manager will have a formal or informal tracking strategy for monitoring the status of data submitted.

5.2. Data analysis and interpretation

A database generated from routine laboratory results permits a broad array of analysis possibilities. Initial views of the data often permit a broad description of laboratory utilisation practices, microorganism epidemiology, and trends in antimicrobial susceptibility.

Further analyses, often stratified by epidemiologically relevant variables, address priority issues in greater detail. Such issues may be previously selected for ongoing monitoring, such as MRSA or blood isolations from the nursery, while others may be suggested by the initial data overview, such as community outbreaks of *Shigella* or the first appearance in a hospital of certain multi-resistant non-fermenting Gram-negative bacilli.

Primary areas of data analysis include continuous quality improvement in microbiological test quality and laboratory service utilisation, and epidemiology of bacterial populations.

1. ***Determination of organism frequencies:*** Examination of organism frequencies highlights the most commonly isolated organisms and findings of infrequent, important species. At the local level, frequencies may easily be stratified by patient department, clinic, specimen type, age, or other relevant demographic variable. When stratified by date, a monthly review of organism frequencies is an important aid in the early detection of hospital or community outbreaks. At the national level, analyses by region or type of health care facility may be of interest.

2. ***Alerts of important resistant pathogens:*** Because of their public health importance, the data analyst should monitor carefully certain findings. The list should be adapted in light of local resistance issues, but may include methicillin-resistant *S. aureus*, ESBL-producing enterics, and penicillin-resistant *S. pneumoniae*. The analyst should also be alert to the appearance of rare or unexpected resistance phenotypes, for example chloramphenicol-resistant *N. meningitidis*. If possible, important findings should be confirmed by repeat testing by the laboratory and national reference centre. A computerised expert system can be of value in identifying such infrequent findings.

3. ***Review of resistance statistics for priority microorganisms:*** More detailed analyses should be done on key species with specific or major resistance issues. Trends should be followed over time, and major movements in statistics may suggest the need for further investigation and action. At the institution level, appropriate stratification of data, for example outpatient/inpatient/ICU, urine/non-urine, may be useful. At the national level, a comparison of results

by region and type of health-care facility is valuable in characterising national trends. "Bench-marking" of institution-level resistance findings permits the identification of "outliers", health centres with unexpectedly high or low levels of resistance. Further study of these institutions may suggest a number of possible explanations: patient demographics, practices for specimen collection, infection control issues, or antimicrobial use patterns.

4. ***Additional analyses:*** For deeper investigation of certain priority organisms, supplementary analyses are of great value. Isolate listings, histograms, antimicrobial scatterplots, and resistance profile analyses are useful in documenting cross-resistance between antimicrobial classes, characterising resistance subpopulations in outbreak investigations, investigation risk factors for resistance, or explorations of specific patient populations or clinical settings.

5.3. Data bias

The microbiologist and data analyst must be aware of limitations in data sets when drawing conclusions, particularly when results are closely tied to antimicrobial use policy. Biases in estimates of percent resistance due to patient recruitment and specimen collection practices are a major concern. Issues of biases in laboratory test practices, for example the selective testing of second-line agents, must also be considered.

Most surveillance programmes, including most targeted surveillance protocols, rely on specimens collected in the course of routine, clinical care. Results primarily reflect that subset of infected individuals who present to medical care in which a health practitioner decides to take a diagnostic specimen. The interpretation of surveillance findings thus requires an appreciation of the clinical population about which conclusions can be safely drawn.

Biased data are frequently used very effectively to guide public health policy, but caution is certainly advised. The most important aspect of dealing with bias is alertness to the potential impact it may have on conclusions. In issues of greatest concern, occasional validation surveys may be useful in investigating and quantifying bias. If findings in the more intensive validation survey support findings from the ongoing surveillance programmes, greater confidence can be placed in the findings. However, if results conflict in important ways, network coordinator may wish to incorporate the "validation" survey as a specific targeted surveillance protocol in the ongoing surveillance plan, for example on a biannual basis.

5.4. Feedback to submitting institutions

An important aspect of feedback by network coordinators is improving the ability of local staff to evaluate their own data and to act on important findings through communications with local pharmacy, clinical, infection control, and public health workers. Local microbiologists and epidemiologists should understand the public health and clinical significance of the resistance findings, as well as the possible biases that should be borne in mind when developing policy. Local staff should be particularly attuned to events that warrant prompt action, such as outbreaks or new resistance problems.

National comparisons are valuable in identifying challenges common to all institutions, while highlighting differences that may be of particular importance in certain areas. For institutions with particularly high or low levels of resistance, further investigations may be revealing. High rates of resistance may be attributable to institution and patient demographics (health clinic, tertiary care centre, paediatric population, etc.), regional differences, antimicrobial use practices, or infection control and sanitation problems. Certain findings may suggest specific interventions such as modifications in antibiotic use policy or improvements in standards of hygiene.

5.5. Data dissemination and use

Surveillance findings will be made widely available to healthcare professionals, national authorities, industry, researchers, and media representatives. A detail annual report should be available to network participants – covering a summary of network activities, detailed resistance findings in tables and graphs, quality assurance assessments, and discussion and interpretation of major findings. The attention of national authorities involved in development of drug policy will be drawn towards those organisms relevant to national treatment programmes.

Besides annual reports, other means of disseminating written results include network newsletters and bulletins, policy papers, scientific presentations and publications, web sites, posters, articles in local newspapers, and patient brochures.

In the past several years, significant advances have been made in many countries worldwide in improving the quality and extent of resistance surveillance. There have, however, been fewer efforts to use surveillance data in improving patient care and public health outcomes. This has in part been due to: insufficient efforts by surveillance groups to influence public health action, inadequate links with responsible national and professional bodies, and unsuccessful or misdirected interventions undertaken by policy makers.

Thus while surveillance groups strive to improve the description and understanding of resistant bacterial populations, parallel efforts to improve the effectiveness of local and national authorities and their links with surveillance groups must be undertaken. This may be accomplished through the a national intersectoral task force, as recommended by the WHO as a fundamental priority in national strategies for containment of resistance.

While one use of surveillance findings is in guiding antimicrobial use policy, other important areas of use are alerts of important resistance phenotypes, early detection of outbreaks, improvements in the quality of diagnostic testing to support patient care, and highlighting certain issues which merit deeper investigations.

6. QUALITY ASSURANCE

Whether testing is performed at the peripheral or central level, the surveillance network requires mechanisms for assuring standards in microbiological test performance and reagent quality in a process of continuous quality improvement. The quality of results depends not only on the reliability of antimicrobial susceptibility tests, but also on all aspects of specimen collection, processing, and evaluation.

To ensure consistency in testing practices and to facilitate the training of new technologists, many laboratories have developed "standard operating procedures" describing the appropriate work-up of clinical specimens. If the practices of some laboratories are not considered adequate, network coordinator may find it worthwhile to develop model standard operating procedures that could be adapted by network participants. The focus of the following discussion is assuring the quality of antimicrobial susceptibility test results.

6.1. Internal quality assurance

6.1.1 Quality control strains

Laboratories require procedures for assuring the quality of test reagents and the adequacy of test performance. The first line of assessment of susceptibility test results is the use of standard quality control strains. As the standardised method for susceptibility testing used nationwide is the method published and maintained by the United States Clinical and Laboratory Standards Institute (CLSI), the following guidelines are based on CLSI recommendations. For the testing of aerobic microorganisms, CLSI recommends testing of the following strains:

Non-fastidious	
ATCC 25922	*Escherichia coli*
ATCC 27853	*Pseudomonas aeruginosa*
ATCC 25923	*Staphylococcus aureus* (for disk diffusion testing only)
ATCC 29213	*Staphylococcus aureus* (for MIC testing only)
ATCC 43300	*Staphylococcus aureus* (MRSA)
ATCC 29212	*Enterococcus faecalis*
Fastidious	
ATCC 49619	*Streptococcus pneumoniae*
ATCC 49766	*Haemophilus influenzae*
ATCC 49226	*Neisseria gonorrhoeae*

6.1.2 Additional procedures

Quality control testing of standard strains provides a useful assessment of the quality of test reagents and test performance. To educate laboratories in the identification of implausible, infrequent, or important phenotypes, a list of susceptibility test results that should not be reported without confirmation, for example by re-testing and re-identification is made available to participating laboratories. (Appendix 4)

6.2. External quality assurance

6.2.1 Proficiency test programmes

Participation in external quality assurance schemes has proven of value in helping laboratories identify and correct problems in test performance, in evaluating laboratory proficiency for participation in network collaborations, and in updating microbiologists in emerging issues of resistance and diagnostic techniques.

At a minimum, the quality assurance programme should cover organism identification, susceptibility testing, and test interpretation. Several programmes also address specimen processing and appropriate reporting of results for use by clinicians.

For participation in a national surveillance network, enrolment in an external proficiency testing programme is usually required. The surveillance network coordinator initiates a quality assurance programme specifically developed for the needs of the surveillance programme.

6.2.2 Confirmatory testing

For strains with important or unusual phenotypes identified by participating laboratories, there will be some mechanisms for confirming results at a central level.

If the results of the sending laboratory are incorrect, then directed feedback with appropriate guidance should be returned to the laboratory. Central confirmation of the results permits more definitive statements about the existence of certain resistance phenotypes in the country.

For strains of significant international public health importance, for example vancomycin-resistant *S. aureus* or fluoroquinolone-resistant *Salmonella* typhi, further confirmation and characterisation by a recognised international reference laboratory are advised. In this way, the mechanisms established to assure surveillance data quality can also contribute to a global alert network for new and emerging resistance issues.

7. BENEFIT OF THE MARSS

This surveillance system will provide the information necessary to secure an approach to the management of communicable diseases that minimises morbidity and mortality whilst also containing the emergence of pathogens resistant to antimicrobials. The principal uses of the information gained from surveillance are to optimise the use of antimicrobials and assist in the prevention, control and containment of antimicrobial resistance at the local, regional and national levels.

8. CONCLUSION

Antimicrobial resistance is one of the modern day public health problems we face. The mechanism for the development of this problem is very complex. From the human aspect, indiscriminate use of antimicrobial agents by medical practitioners and public demand for drugs are said to be the main causative factors for this problem. The problem is further complicated by use of antimicrobial drugs in veterinary and husbandry practises that contribute to excessive exposure of the organism to the antimicrobial agent. As a response to this exposure, organisms use their survival instincts and capabilities to overcome the pressure to their existence. Due to the complexities of the organisms themselves, it is really difficult to understand their evolution and survival mechanisms.. However, to win this war we need all the information available to us so we can take preemptive action if a antimicrobial-resistant organism emerges either currently or in the future. As Sun Tzu quoted in The Art of War - “what enables the wise sovereign and the good general to strike and conquer, and achieve things beyond the reach of ordinary men, is foreknowledge”.

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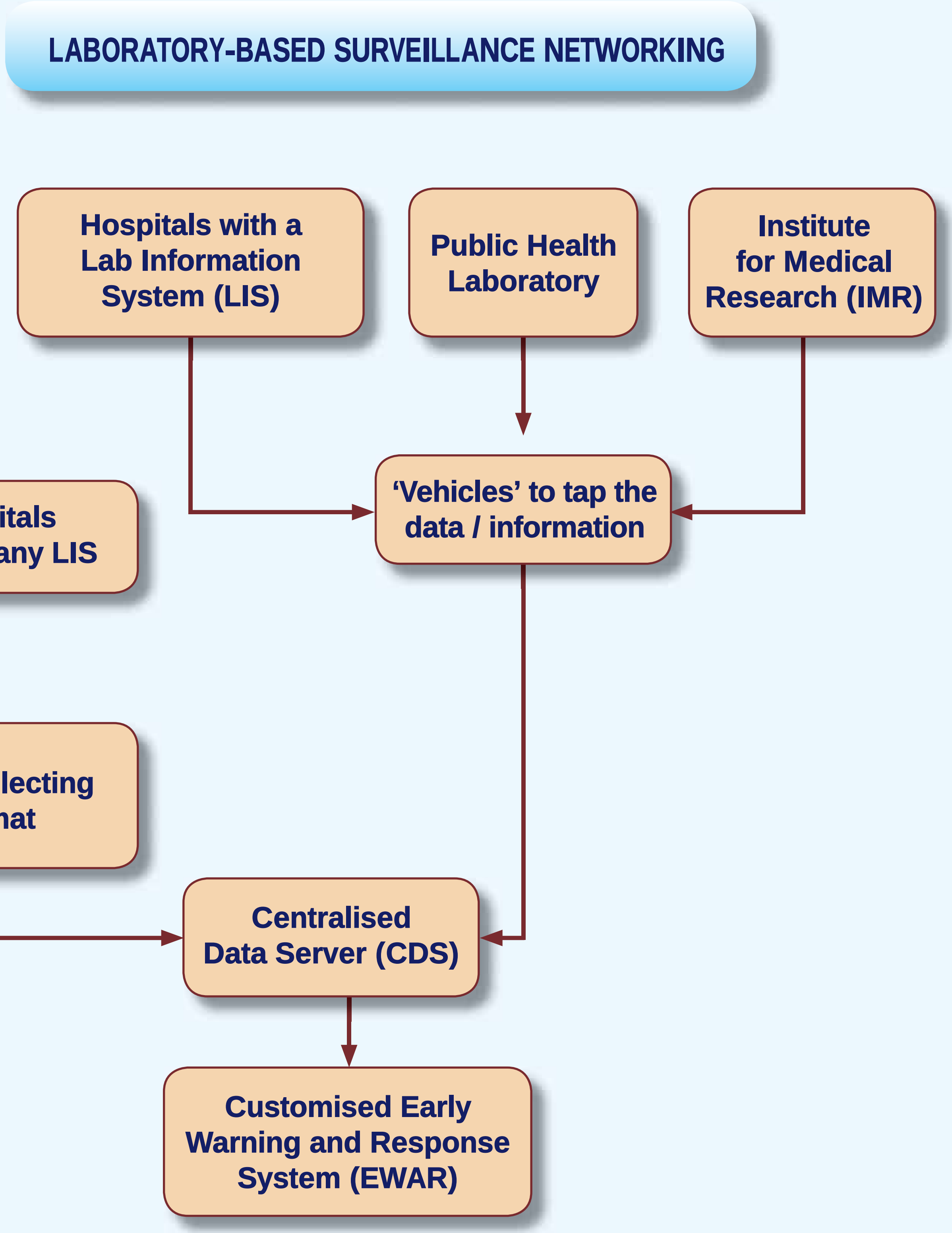
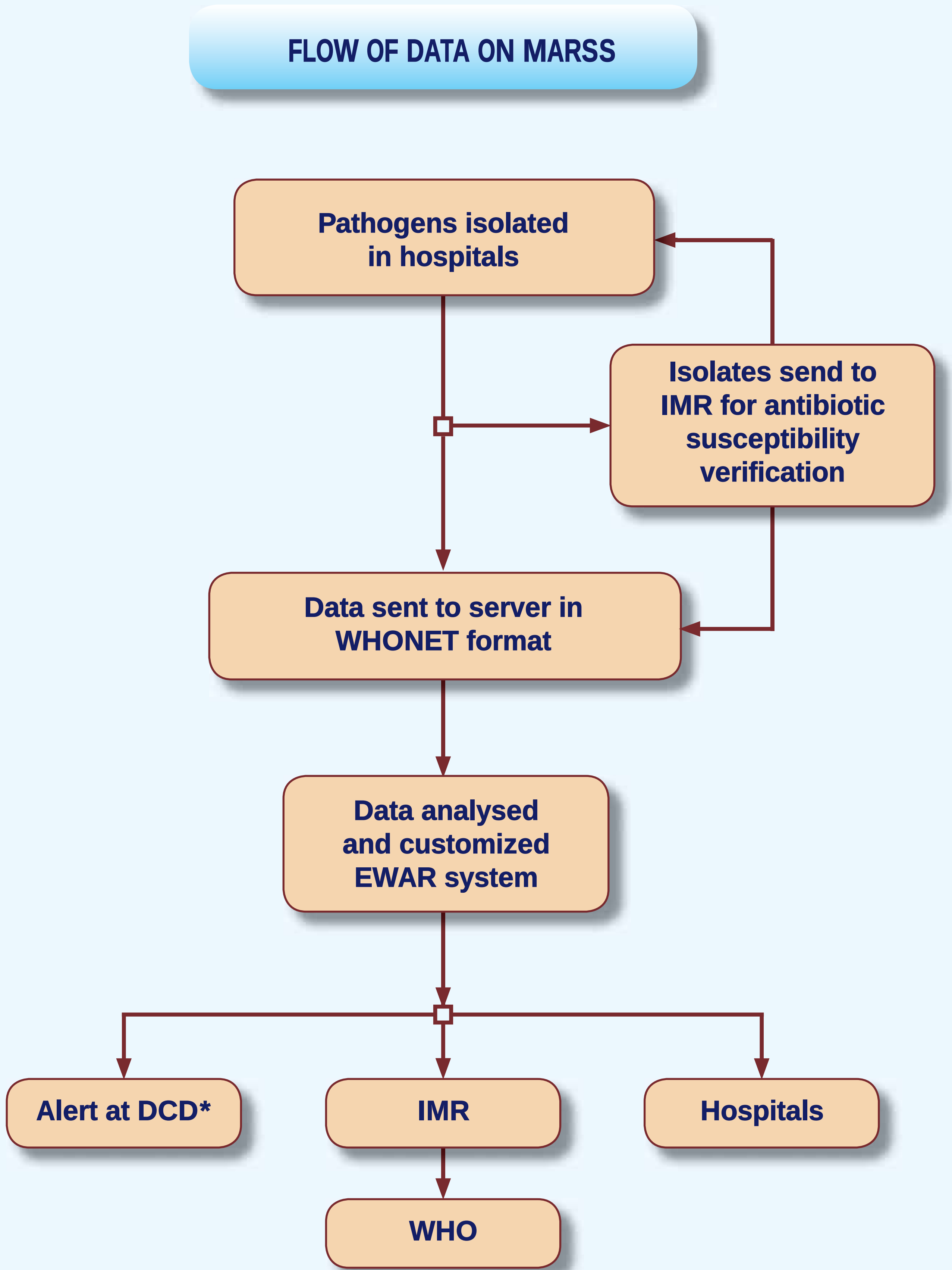
We would like to thank the Pathologists (Microbiology), Scientific Officers (Microbiology) Infectious Disease Specialists, Paediatricians, O&G Specialists, Surgeons and all individuals who have contributed to the development of this guidelines.

APPENDICES

Appendix 1


LABORATORY-BASED SURVEILLANCE NETWORKING
Hospitals with a Lab Information System (LIS)
Public Health Laboratory
Institute for Medical Research (IMR)
'Vehicles' to tap the data / information
Hospitals without any LIS
Data collecting format
Centralised Data Server (CDS)
Customised Early Warning and Response System (EWAR)

Appendix 2



* DCD= Disease Control Division, MOH

ANTIBIOTIC TESTING PANEL FOR NATIONAL SURVEILLANCE ANTIBIOTIC RESISTANCE (NSAR)

1. This list is of the minumum number of antibiotics to be tested for the surveillance.
2. Additional antibiotics to be added if required.

Staphylococcus (non-urine)		Gram positive cocci (in urine)	
Plate 1 Penicillin Oxacillin Erythromycin Trimethoprim/ sulfamethoxazole Gentamicin	**Plate 2** Fusidic acid Rifampicin Vancomycin Clindamycin	Oxacillin Trimethoprim/ sulfamethoxazole Gentamicin	Vancomycin Nitrofurantoin Ampicillin

Enterobacteriaceae (non-urine)		Gram negative bacilli (in urine)	
Plate 1 Ampicillin Cefoperazone/ ceftriaxone Cefuroxime Gentamicin Amikacin Trimethoprim/ sulfamethoxazole	**Plate 2** Amoxicillin/clavulanic acid Ceftazidime Meropenem Imipenem Cefotaxime/ceftriaxone Ciprofloxacin	**Plate 1** Ampicillin Trimethoprim/ sulfamethoxazole Nitrofurantoin Cefuroxime Gentamicin Amoxicillin/clavulanic acid	**Plate 2** Ciprofloxacin Ceftazidime Meropenem Cefotaxime Imipenem Amikacin

Enterococcus (non-urine)		*Enterococcus* (in urine)	
Ampicillin Gentamicin (120 μg)	Vancomycin Linezolid	Ampicillin Gentamicin Nitrofurantoin	Vancomycin Ciprofloxacin

Streptococcus pneumoniae		*Burkholderia pseudomallei*	
Oxacillin (for penicillin) Erythromycin Tetracycline	Trimethoprim/ sulfamethoxazole Ceftriaxone Vancomycin	Ceftazidime Trimethoprim/ sulfamethoxazole Meropenem Imipenem	Ciprofloxacin Chloramphenicol Tetracycline Amoxicillin/clavulanic acid

B-haemolytic Streptococcus		***Stenotrophomonas maltophilia***	
Penicillin Erythromycin Tetracycline	Trimethoprim/ sulfamethoxazole Clindamycin Cephalexin	Trimethoprim/ sulfamethoxazole Tetracycline Minocycline Levofloxacin	Imipenem: Not for reporting, used as a guide for identification.

***Pseudomonas* & Non-fermenter**		***Acinetobacter***	
Plate 1 Ceftazidime Gentamicin Amikacin Cefoperazone Piperacillin	**Plate 2** Meropenem Imipenem Piperacillin/tazobactam Ciprofloxacin Cefepime	**Plate 1** Ceftazidime Gentamicin Amikacin Piperacillin Ampicillin/sulbactam	**Plate 2** Meropenem Imipenem Ciprofloxacin Sulbactam/cefoperazone Netilmicin Piperacillin/tazobactam

Moraxella catarrhalis		***N. gonorrhoeae***	
Ampicillin Amoxicillin/clavulanic acid	Tetracycline Levofloxacin	Penicillin Ciprofloxacin Kanamycin Tetracycline	Ceftriaxone

H. influenzae		***Salmonella* Typhi *and Salmonella species***	
Ampicillin Chloramphenicol Cefuroxime/ ceftriaxone*	Cefotaxime Amoxicillin/clavulanic acid Trimethoprim/ sulfamethoxazole	Chloramphenicol Ampicillin Ciprofloxacin	Ceftriaxone Trimethoprim/ sulfamethoxazole

*Note: * For cerebrospinal fluid isolates use ceftriaxone*
This antibiotic panel was derived from the consensus meeting held on March 2007, attended by Pathologists (Microbiology), Scientific Officers (Microbiology) Infectious Disease Specialists, Paediatricians, O&G Specialists and Surgeons. We would like to thank all of them for their contribution.

ALERT ORGANISMS

Resistant Organisms to be Verified by Central Coordinating Laboratory

1. Vancomycin-resistant *Enterococcus*
2. Vancomycin-resistant or Intermediate *Staphylococcus aureus*
3. Penicillin-resistant *Streptococcus pneumoniae*
4. Penicillin-resistant *Streptococcus pyogenes*
5. Penicillin-resistant *Streptococcus agalactiae*
6. Carbapenem-resistant *Klebsiella*
7. Carbapenem-resistant *Enterobacter*
8. Carbapenem-resistant *E. coli*
9. Chloramphenicol-resistant *Salmonella* Typhi
10. Quinolone-resistant *Salmonella* Typhi
11. Tetracycline-resistant *Vibrio cholerae*
12. Ampicillin-resistant *H. influenzae*
13. Chloramphenicol-resistant *H. influenzae*

Bacterial nomenclature as per American Medical Association house style

Alert Organisms for Hospitals

1. Vancomycin-resistant *Enterococcus*
2. Vancomycin-resistant or Intermediate *Staphylococcus aureus*
3. Penicillin-resistant *Streptococcus pneumoniae*
4. Penicillin-resistant *Streptococcus pyogenes*
5. Penicillin-resistant *Streptococcus agalactiae*
6. Carbapenem-resistant *Klebsiella*
7. Carbapenem-resistant *Enterobacter*
8. Carbapenem-resistant *E. coli*
9. Chloramphenicol-resistant *Salmonella* Typhi
10. Quinolone-resistant *Salmonella* Typhi
11. Tetracycline-resistant *Vibrio cholerae*
12. Ampicillin-resistant *H. influenzae*
13. Chloramphenicol-resistant *H. influenzae*
14. *N. meningitidis*
15. *V. cholerae*
16. *Salmonella*
17. *ESBL: *E. coli, Klebsiella pneumoniae, Klebsiella oxytoca, Proteus mirabilis* for blood isolate only.
18. Multiresistant *S. aureus*
19. Multiresistant organism (MRO): organism resistant to ≥2 groups/class of antimicrobial agents.

*Note: * ESBL = extended-spectrum beta lactamase*
Bacterial nomenclature as per American Medical Association house style

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