# System analysis for AMR morbidity monitoring in Thailand (an exploratory phase)

**International Health Policy Program**

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# System analysis of AMR morbidity monitoring in Thailand: challenges and solutions

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## Part 1: Background

### Project background

Antimicrobial resistance (AMR) is one of public health challenges worldwide. The World Health Organization (WHO) adopted a resolution and endorsed the implementation of the global action plan on AMR in 2015[1,2]. In Thailand, similar AMR challenges called for national responses. The Thailand's national strategic plan on AMR 2017-2021 (NSP-AMR 2017-2021) was endorsed for implementation by the cabinet in August 2017[3]. The plan has introduced a number of actions for combating the country's AMR challenges by several public agencies and other stakeholders across sectors using one health approach.

There are five goals to be achieved by 2021, this includes 1) 50% reduction in AMR morbidity, 2) 20% reduction in antimicrobial use in human, 3) 30% reduction in antimicrobial use in animal, 4) 20% increase of public knowledge on AMR and awareness of appropriate use of antimicrobials, and 5) capacity of the national AMR management system has improved to level 4 based on Joint External Evaluation assessment[3].

Since the strategic plan was endorsed, several implementations have been done with untiring commitments by various sectors. In additional to the implementation, monitoring and evaluation is essential for assessing progress. There is no measurement available for monitoring AMR morbidity while other four national goals have developed monitoring tools and systems. The amount of antimicrobial consumption in both human and animal sectors are monitored by the recently developed tool called Thailand Surveillance of Antimicrobial Consumption (SAC) similar to the European CDC tools; the AMR module embedded in the national Health and Welfare survey conducted biannually by the Thai National Statistical Office are used to monitor public literacy on antibiotics and AMR awareness[4].

There is a need for (a) immediate documenting the baseline prevalence of health care associated infection (HAI) and AMR morbidity as soon as possible which are the results of infection prevention and control practices and improved antimicrobial stewardship; and (b) establishing a robust and sustainable national system for regular monitoring prevalence of HAI and AMR.

Currently, there are eight AMR related databases hosted by various departments in MOPH including Bamrasnaradura Infectious Disease Institute (BIDI), Department of Medical Sciences (DMSC), Bureau of Epidemiology, Health Administration Division, and Healthcare Accreditation Institute. All of these platforms have potentials to be streamlined and harmonized into a single national HAI and AMR prevalence monitoring system. Streamlining will ensure synergies, avoid duplication and unnecessary workload by reporting hospitals, and improve accuracy and efficiency. Each of the eight platforms has its own strengths and limitations.

This study aims to assess the existing hospital information systems which contribute to the estimate of prevalence of HAI and AMR morbidity, identify strengths and gap of data systems at hospital and national level; and recommend policies for "an effective national HAI and AMR morbidity monitoring systems".

## Objectives

1. To assess the strengths and weaknesses of the existing information systems at hospital and national level which contribute to monitoring the prevalence of HAI and AMR morbidity
2. To provide policy recommendation for an effective national monitoring system on the prevalence or incidence of HAI and AMR morbidity.

## Methodology

1. Data collection

This study applies a qualitative study method, consisting of 1) literature reviews, 2) focus group discussions and in-depth interviews with key informants, and 3) a consultative meeting with key stakeholders.

1.1 literature reviews

Both international and national published and gray literatures were reviewed. This aims to gain understanding of the methodology which were used to monitor AMR morbidity or AMR surveillance system at global and national levels.

1.2 Focus group discussions and in-depth interviews with key informants

This method explores and analyzes all existing AMR and HAIs surveillance tools used in Thai hospitals which may contribute to the estimate of HAI and AMR morbidity. Three groups of key informants covered by this study are: 1) healthcare practitioners in sampled hospitals, 2) program managers of AMR surveillance in MOPH and other organizations, and 3) technical experts including infectious diseases control and health information. These methods responded to the first objective of this study.

Interviews at hospital level, purposive sampling was applied to select ten hospitals which represent all hospitals types including three regional hospitals, two provincial hospitals, one district hospital, one hospital under the Department of Medical Service, MOPH; two non-MOPH public hospitals, and one private hospital. These hospitals may have different data systems and capacities in data collection. The key informants in these hospitals were AMR-focal points, infectious control nurses, and laboratory technicians who were responsible for AMR data collection and those who were responsible for AMR and IPC programs (see table 1). This interview provided better understanding of their current workload on diagnosis of HAI and AMR, data entering, data verifications and use of HAI/AMR information to improve hospital level IPC systems.

In these selected hospitals, we identified key informants using the following inclusion criteria, 1) healthcare practitioner working in a hospital that was responsible for HAI surveillance, Thailand GLASS, or other AMR surveillance system, and 2) healthcare professionals having experiences on AMR and HAIs data system in their hospital. The exclusion criteria was health professional who was uncomfortable to be interviewed. The researchers had field visits to all sample hospitals for analyzing the hospital information systems which contribute to HAIs and AMR morbidity.

Interview at national level, all existing AMR-related information or surveillance systems in Thailand were identified, where focal points responsible for each program were interviewed. These programs are 1) HAI surveillance system, 2) Point prevalence survey on HAI, 3) National Antimicrobial Resistance Surveillance System, 4) Thailand Global Antimicrobial Resistance Surveillance System, 5) Thailand Hospital Indicator Program, 6) Development of National AMR surveillance and response system, 7) AMR case report, and 8) AMR service plan report.

For expert groups, purposive sampling was applied to select the experts having experiences on infectious prevention and control, or health information system (see table 1).

Table 1: type of organization and number of interviewees in this study

| | | Key informant interviews | | | | | |
|---|---|---|---|---|---|---|---|
| Type of hospital/organization | Number of organizations | ICNs | Doctors/ ID doctors | Lab scientists | ID experts | IT experts | MOPH officers |
| Hospital level interviews | | | | | | | |
| BKK | | | | | | | |
| • University hospital | 1 | 3 | 1 | 1 | | | |
| • DMS hospital | 1 | 2 | - | 1 | | | |
| • BMA hospital | 1 | 1 | 2 | 1 | | | |
| • Private hospital | 1 | 3 | - | 1 | | | |
| South | | | | | | | |
| • District hospital | 1 | 1 | 1 | 1 | | | |
| • Provincial hospital | 1 | 2 | 1 | 1 | | | |
| • Regional hospital | 1 | 5 | 1 | 1 | | | |
| East | | | | | | | |
| • Provincial hospital | 1 | 1 | 1 | 1 | | | |
| • Regional hospital | 2 | 5 | 1 | 2 | | | |
| National level interviews | | | | | | | |
| • MOPH | | | | | | | |
| • University | 3 | | | | - | 1 | 6 |
| • Program vender | 1 | | | | 1 | 1 | - |
| • NHSO | 1 | | | | - | 1 | - |
| | 1 | | | | - | 1 | - |
| **Total** | **16** | **23** | **8** | **10** | **1** | **4** | **6** |

Note: DMS Department of Medical Service, BMA Bangkok Metropolitan Authority, NHSO National Health Security Office, ICN Infectious Control Nurse, ID Infectious Disease

Semi-structured interview was applied for in-depth interviews. An interview guideline was designed to explore the input, process, output, and outcome of the AMR data system in the hospital and national level (see figure 1). A few questions on the future design of HAI and AMR morbidity monitoring systems were asked to probe the most feasible, practical and user-friendly system for Thailand.

The researchers informed all key informants of the project's objectives, the contents in the interview guideline. In addition, the interviewees were asked with open-ended questions following the interview guideline (see annex 1).

1.3 Consultative meeting

This consultation with wider stakeholders was convened which aimed to verify the preliminary findings, and reach consensus on the most effective national HAI and AMR prevalence monitoring tool(s) based on findings from this study.

This meeting was convened on 4th March 2019. There were key stakeholders participating in the meeting, which included technical experts on AMR and IPC, infectious control nurses (ICN), infectious disease experts, epidemiologists, hospital administrators, AMR national focal point, National Health Security Office (NHSO), and health information experts (see annex 2). The consultative meeting responds to the second objective of this study.

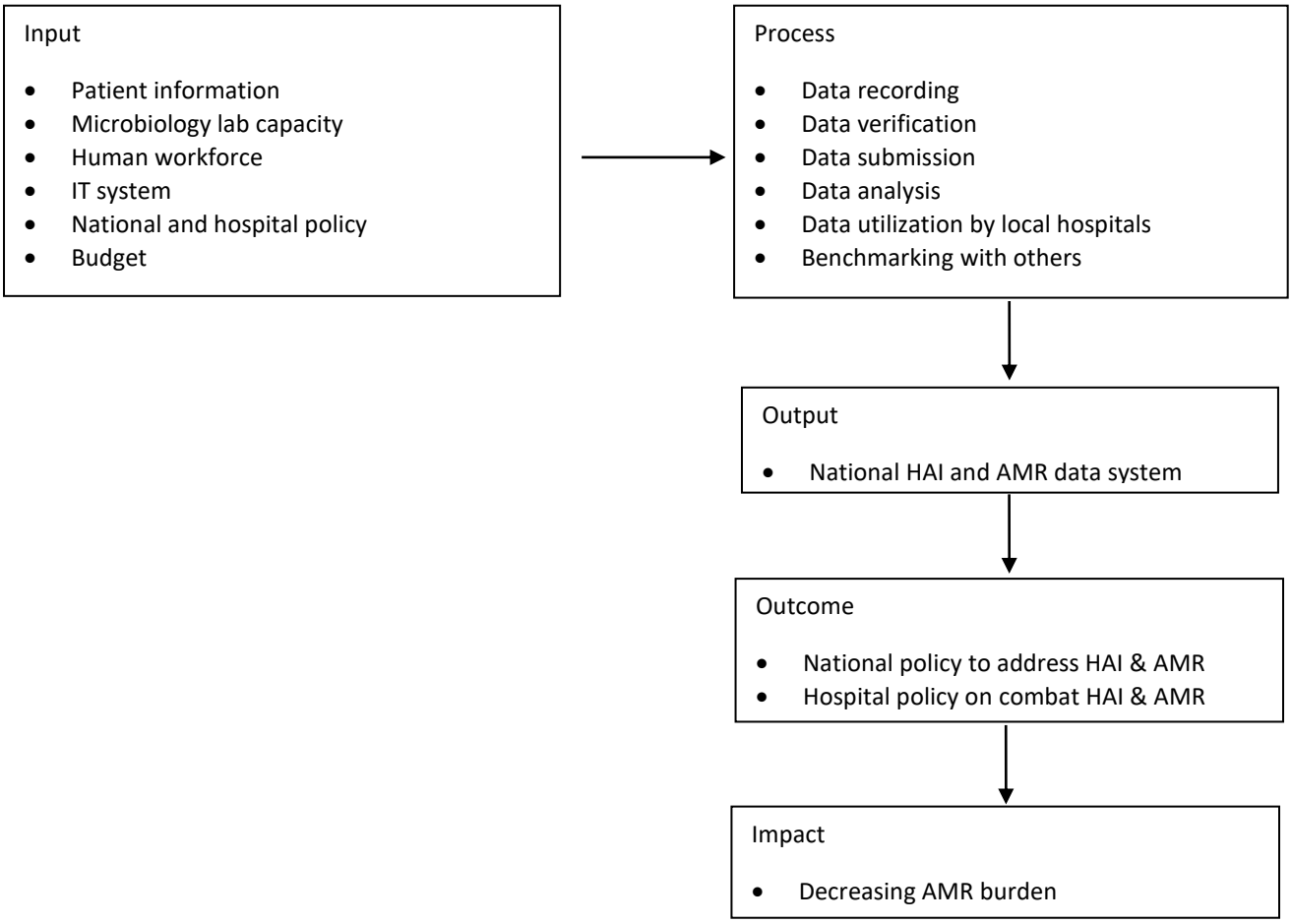
2. Data analysis

Given the inputs from literature reviews, systems analysis and stakeholder interviews and consultations, data was triangulated, analyzed, and synthesized using content analysis method. This aimed to identify both strengths and limitations of each AMR and HAIs information system. In addition, this study also proposes a system design for future national AMR and HAIs morbidity monitoring platform(s).

3. Ethical clearance

This research was approved on scientific, ICH-GCP, and ethical issue by the ethical committee of Institute for the Development of Human Research Protection (IHRP) on 21 January 2019, an approval date.

Figure 1: Conceptual framework



## Part 2: Results

### 1. AMR surveillance system at global level: a review of literature

**Key findings**

- There is no global standard on AMR morbidity measurement. Findings in Table 2 are all from high income countries.
- Evidence shows that there is a large capacity gap in monitoring AMR morbidity in LMICs.
- Several publications have reported the burden of AMR by specific pathogens; most of them are research-based, not national representation.
- Although many high income countries and some developing countries have developed their surveillance systems to monitor AMR, most of them are lab-based surveillance which lack of patient based clinical information; except the most recent GLASS report which provides AMR incidence per 100,000 tested patients. Large gaps are identified. There is neither report on the number of mortality attributable to AMR; population attributable fraction; nor economic losses from AMR mortality.
- There are global and regional AMR surveillance networks such as ECDC-PPS, CAESAR, EARS-net, Global-PPS, and GLASS (see table 2). There are at least seven platforms, five global and regional, and two country levels (US CDC and JANIS).
- In 2015, the WHO launched the Global Antimicrobial Resistance Surveillance System (GLASS) which aimed to use this as a global platform to monitoring AMR morbidity, extended from laboratory based. The latest 2017-2018 GLASS report was launched in 2019. There are 69 counties participating in GLASS[5].

Table 2: Summary profiles of seven global, regional and national AMR surveillance systems

| | Global/regional Platforms | | | | | National Platforms | |
|---|---|---|---|---|---|---|---|
| **Details** | **1 ECDC-Point prevalence survey** | **2 Global-point prevalence survey** | **3 Central Asian and Eastern European Surveillance of Antimicrobial Resistance (CAESAR)** | **4 Global Antimicrobial Resistance Surveillance System (GLASS)** | **5 European Antimicrobial Resistance Surveillance Network (EARS-Net)** | **6 National Healthcare Safety Network - Antimicrobial Use and Resistance (AUR) Module** | **7 Japan Nosocomial Infections Surveillance (JANIS)** |
| **Organization** | ECDC | GLOBAL-PPS Development Group hosted by Univesity of Antwerp | WHO-Europe | WHO | ECDC | US-CDC | Japan National Institute of Infectious Control |
| **Start since** | 2011 | 2015 | 2014 | 2015 | 1998 | - | 2000 |
| **Approach** | PPS on hospital associated infection and antimicrobial use | PPS on antimicrobial use and antimicrobial resistance | Lab-based surveillance | Case-finding based on clinical specimen surveillance | Lab-based surveillance | Case-based surveillance | Lab-based surveillance |
| **N of countries (hospitals)** | 30 (1,149) | 53 (335) | 9 | 42 | 30 (>1,600) | 1 (4,515) | 1 (1,840) |
| **AMR reported indicator** | % of AMR in positive culture specimens (patient with HAI) | % of patient used ATB for AMR in patients prescribed ATB | % of AMR in positive culture specimen | 1. Proportion of non−susceptible isolates<br>2. AMR incidence per 100,000 tested patients | % of AMR in positive culture specimen | % of AMR in positive culture specimen | % of AMR in all specimens |
| **Numerator** | N of AMR by organism | N of patients prescribed ATB for treatment AMR | N of AMR by organism | N of AMR by organism by specimen | N of AMR by organism | N of AMR by organism | N of AMR by organism |
| **Denominator** | Total N of positive specimens by organism | Total N of patient prescribed ATB | Total N of positive specimens by organism | 1. Total N of positive specimens by organism<br>2. Total N of submitted specimens | Total N of positive specimens by organism | Total N of positive specimens by organism | Total N of submitted specimens |

| | Global/regional Platforms | | | | | National Platforms | |
|---|---|---|---|---|---|---|---|
| **Details** | **1 ECDC-Point prevalence survey** | **2 Global-point prevalence survey** | **3 Central Asian and Eastern European Surveillance of Antimicrobial Resistance (CAESAR)** | **4 Global Antimicrobial Resistance Surveillance System (GLASS)** | **5 European Antimicrobial Resistance Surveillance Network (EARS-Net)** | **6 National Healthcare Safety Network - Antimicrobial Use and Resistance (AUR) Module** | **7 Japan Nosocomial Infections Surveillance (JANIS)** |
| **Specimen** | All types | All types | Blood, CSF | Blood, urine, faeces, urethral/vaginal | Blood, CSF | Blood, urine, lower respiratory, CSF | All types |
| **N of targeted organisms** | 5 | 9 | 9 | 8 | 7 | 20 | 8 |
| **Patient data** | Yes, with clinical data | Yes, with clinical data | Yes, no clinical data | Yes, no clinical data | Yes, no clinical data | Yes, with clinical data | No |
| **Frequency** | Every five years | Annually | Quarterly | Annually | Annually | Monthly | Monthly |

Data sources: ECDC-PPS[6], the Global-PPS[7], US-CDC[8], CAESAR[9], EARS-Net[10], JANIS[11], GLASS[5]

## 2. AMR surveillance systems in Thailand: a comprehensive assessment

### Key findings

- Currently, there are nine AMR monitoring systems in Thailand hospital sector and national HAI/AMR surveillance systems.
    1) Hospital's routine HAI surveillance system,
    2) National HAI surveillance system,
    3) National point prevalence survey of HAIs,
    4) National antimicrobial resistant surveillance Thailand (NARST),
    5) AMR indicator in AMR service plan program,
    6) Thailand hospital indicator program 2 (THIP2: infectious control module),
    7) Thailand global antimicrobial surveillance system (GLASS),
    8) Development of national AMR surveillance and response system (DeNARS), and
    9) AMR case report.
- These nine platforms have been gradually and fragmentedly developed since 1988, there was an accelerated coverage and performance of these systems soon after the NSP-AMR 2017-2021 was endorsed. Three out of the nine systems are at the initial phase of development which are implemented in only six hospitals; these are GLASS, DeNARS and AMR case report.
- While almost all of them are hosted and organized by four organizations in the MOPH, only hospital's routine surveillance (platform 1 in table 3) is voluntarily self-conducted by frontline ICNs for their routine monitoring and hospital own use for IPC improvement.
- In term of data collection, we identified three data collection approaches;
    - Cross sectional point prevalence survey
    - Prospective case-based surveillance
    - Prospective lab-based surveillance.
- All of them are voluntary except the MOPH service plan's AMR indicator (Platform 5) is mandatory implemented in MOPH general and regional hospitals as part of the key performance of these hospitals.
- Duplication across these nine platforms is a major challenge and creates unnecessary burden of data collection especially by hospitals. We identified three data source systems
    - **ICNs originated system**: hospital HAIs surveillance (Platform 1), national HAIs surveillance (Platform 2), PPS on HAIs (Platform 3), THIP2 (Platform 6). These four platforms demand the heavy works by ICN and ICWN (Infectious Control Ward Nurses)
    - **Lab originated system**: NARST (Platform 4), AMR service plan's indicator (Platform 5); these two platforms require significant contributions by Medical Technologist/scientists.
    - **Lab and ICNs originated system**: GLASS (Thailand) (Platform 7), DeNARS (Platform 8), AMR case report (Platform 9); both platform require contribution by medical technologist and ICNs.
- We identified a few major weaknesses, there are lack of feedback loop to data providers, lack of data verification, there is no report on benchmarking with other peer hospitals (except THIP2), and ensuring hospitals benefit from their data sharing/submission which hampers quality of data submission. The accountability framework and interactive processes between conveners and hospitals are essential to generate sense of ownership among hospital administrations, ICN, laboratory scientists and focal points which are the critical success factors for reliable lab based and patient-based HAI and AMR morbidity.
- As mandated by the 2015 Communicable Disease Act (2558 BE), the Department of Diseases Control are planning to introduce five highly pathogenic AMR as a mandatory dangerous communicable disease list which required mandatory reporting; and to introduce HAIs as

notifiable communicable disease list. These movements are enabling opportunity to a more complete and reliable HAIs reporting.

- Along with GLASS implementation, DMSC is planning data management and linkage between the microbiological data (lab-based AMR surveillance in NARST) and the MOPH's 43 folders program (patient-based information systems). This will be an opportunity to combine patient-based AMR morbidity and lab based without data entering burden. However, a remaining challenge is the inclusion of private hospitals and non-MOPH public hospital in the NARST and 43 folders.
- These nine AMR monitoring platforms have different purposes, strengths, and limitations. Table 3 summarizes their profiles.

Table 3: Summary profile of nine HAI and AMR surveillance platforms in Thailand

| Platforms | Key Profiles | Findings |
|---|---|---|
| 1.Hospital's routine HAI surveillance | Host | Individual hospital where there are ICN on a voluntary basis |
| | Hospital key actors | ICN |
| | Start since | Unknown, gradually evolved |
| | Indicators produced | – HAI incidence, if data is complete for a year both numerators and denominators.<br>– HAI prevalence<br>– Percentage of AMR in HAI patients |
| | Approach | There are few approaches used in each hospital including<br>1) Hospital wide surveillance,<br>2) Target surveillance of e.g. VAP, CAUTI, CLABSI, and<br>3) Point prevalence survey. |
| | Frequency of data collection | PPS: annually, every 6 months, or quarterly<br>HAI surveillance: monthly |
| | Purpose(s) | – Data collection aims for internal use to improve their IPC<br>– Hospital wide and target surveillances are used for monitoring HAI and IPC practices in each hospital.<br>– PPS is used for a) evaluating accuracy of hospital's surveillance system, and b) estimating HAI prevalence. |
| | Number of participants | This is an ICN's routine practice conducted in all hospitals. |
| | Strengths | – Information is used for self-monitoring.<br>– Capacity to estimate HAI and AMR morbidity rate, not CAI |
| | Limitations | – Due to workload of data collection, some large hospitals prefer target of their interests than hospital wide surveillance.<br>– Private hospitals and university hospitals usually use international HAI definition like CDC definition while MOPH hospitals use Thai HAI definition published by BIDI.<br>– These are conducted by ICNs and team using paper-based system.<br>– Lack of benchmarking between hospitals |
| 2 BIDI's prospective HAI surveillance | Host | BIDI |
| | Hospital key actor | ICN |
| | Started since | 2013 (used an excel file in the first year). Note that this platform relies on the contribution of selected hospital's routine HAI surveillance with high quality data collection |
| | Information collected | – HAI incidence in the inpatients |

| Platforms | Key Profiles | Findings |
|---|---|---|
| | | – Percentage of AMR of total HAI inpatients |
| | Approach | Hospital wide prospective surveillance |
| | Frequency of data submission | Monthly |
| | Purpose(s) | Monitoring HAIs incidence |
| | Number of participants | 535 hospitals in 2019<br>– 378 District hospital<br>– 60 Provincial hospital<br>– 31 Regional hospital<br>– 27 other public hospital<br>– 39 Private hospital |
| | Strengths | – Prospective surveillance<br>– Large number of participating hospitals including public and private hospitals<br>– There is clinical information, e.g. age, sex, ward, diagnosis, etc.<br>– There is data verification for completeness of report. |
| | Limitations | At hospital level<br>– Most of hospitals submit data for national monitoring purpose, not for self-monitoring and local IPC improvement. Hospital ICNs lack the sense of ownership and responsibility.<br>– All hospitals have their monitoring system to collect and analyze it by their own, this program is another duplicating tool and a burden.<br>– There is an immediate data visualization and some benchmarking information, but hospitals still do not maximize use of this program for their routine monitoring.<br>– There is a program manual, but lack of a survey manual/guideline published for local ICNs<br>– There is a report on pathogens, but no AMR data.<br>– Not user-friendly program, need to submit data one by one patient<br>At national level<br>– This program is for HAIs surveillance, no CAIs and HAI referral data from other hospitals.<br>– No validation process of data submitted<br>– There is an annual report, but is not made publicly and widely available.<br>– There is a limited resource to organize and strengthen the system, both human and financial resource. |
| 3 PPS on HAI | Host | BIDI, ICN association, and partners |
| | Hospital key actor | ICN |
| | Started since | 1988 |

| Platforms | Key Profiles | Findings |
|---|---|---|
| | Information collected | HAI point prevalence |
| | Approach | Cross sectional Point prevalence survey |
| | Frequency of data submission | Every 3-5 years, there were seven PPS since 1988, (1988, 1992, 2001, 2006, 2011, 2014, 2018), the latest one was conducted in 2018 |
| | Purpose(s) | Monitoring HAI prevalence |
| | Number of participants | 37 hospitals (2018) |
| | Strengths | – There is a robust methodology due to high experienced working group.<br>– There is clinical information, e.g. age, sex, ward, diagnosis, etc. |
| | Limitations | – Cross-sectional study<br>– There is pathogen data, but lack of AMR data.<br>– PPS is not an appropriated tool for estimating AMR morbidity.<br>– Research-based approach<br>– No community acquired infection data |
| 4 NARST | Host | DMSC |
| | Hospital key actor | Microbiological technicians |
| | Started since | 2000 |
| | Information collected | Percentage of antibiotics susceptibility in each organism [antibiogram with three colour codes] |
| | Approach | Lab based surveillance<br>Report data of 36 pathogens |
| | Frequency of data submission | Monthly |
| | Purpose(s) | National laboratory-based AMR monitoring system |
| | Number of participants | 97 hospitals in 2019<br>– 50 Provincial hospitals<br>– 34 Regional hospitals<br>– 7 University hospitals<br>– 3 other public hospitals<br>– 3 Private hospitals |
| | Strengths | – Reliable information due to selected high-quality microbiological laboratories<br>– Two decades experiences with robust methodology<br>– Simple data submission process<br>– Report antibiogram at national and 12 public health regions<br>– NARST report is one of the service plan indicators. |
| | Limitations | – There is limited case based patient information<br>– No specimen on N. gonorrhea, need to supplement by Bureau of STI of DDC |
| 5 Service plan AMR indicator | Host | Health Administration Division |
| | Hospital key actor | Microbiological technician |

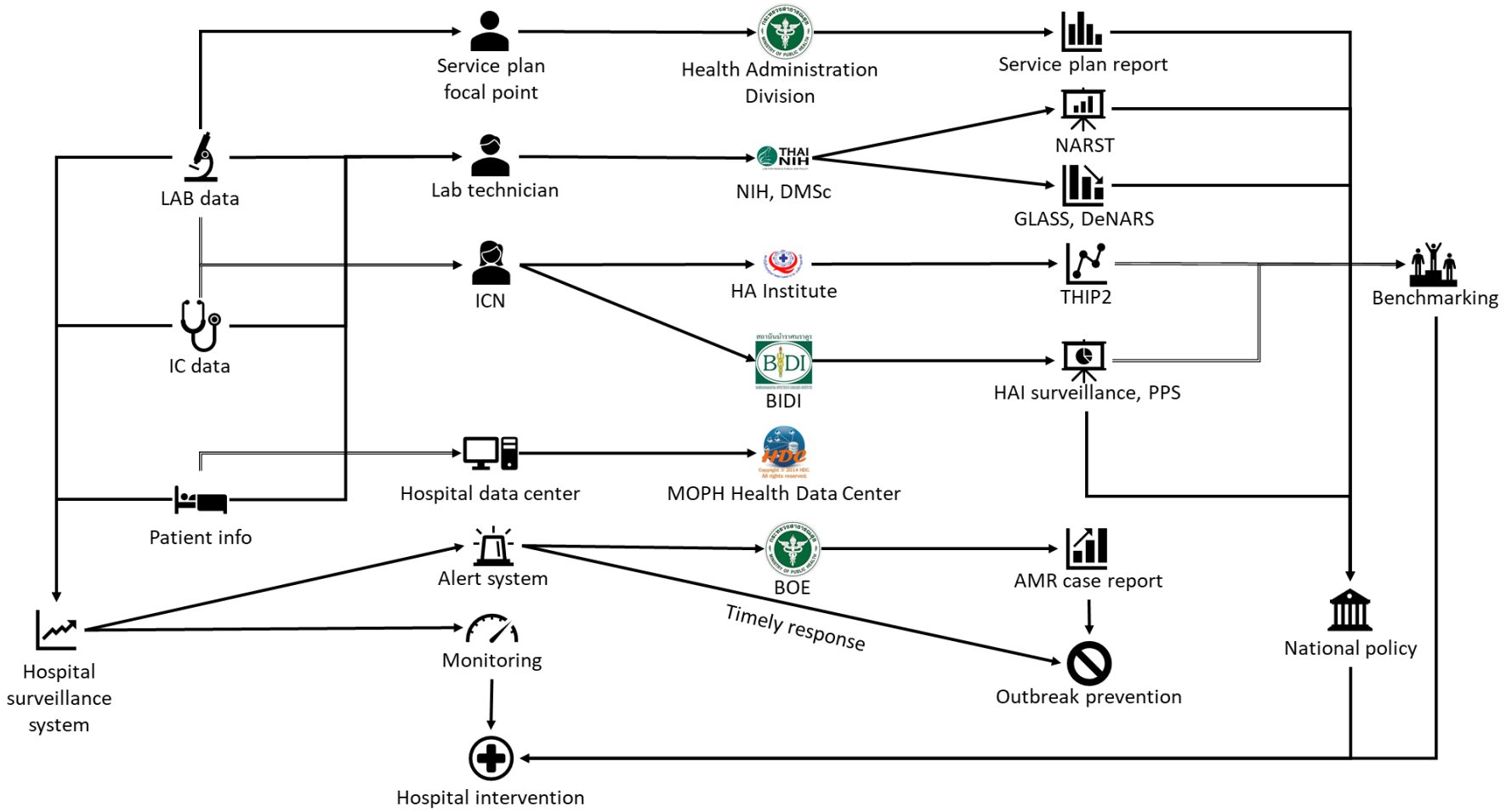
| Platforms | Key Profiles | Findings |
|---|---|---|
| | | Pharmacist - a service plan focal point |
| | Started since | 2017 |
| | Information collected | percentage of AMR septicemia patients per hemoculture tested (8 targeted pathogens) |
| | Approach | Lab based targeted surveillance, only for septicemia |
| | Frequency of data submission | every 6 months |
| | Purpose(s) | AMR monitoring |
| | Number of participants | All regional and provincial hospitals, BMA hospitals, DMS hospitals |
| | Strengths | – Simple data submission process using online webpage<br>– Widely implement in MOPH hospitals |
| | Limitations | – Collect aggregated data, not individual data (total number of antibiotics resistant test for positive hemoculture and total number of patients having hemoculture tested)<br>– No reporting back to healthcare facilities for benchmarking<br>– Monitor only AMR in septicemia<br>– Lack of data verification and validation process<br>– No publicly report |
| 6 THIP2 (IC module) | Host | Healthcare Accreditation Institute |
| | Hospital key actor | ICN<br>THIP focal point |
| | Started since | 2007 |
| | Information collected | – Several IPC indicators,<br>– Incidence of four target HAIs including VAP, CAUTI, CABSI, and SSI (CABG, hip/knee joint replacement, abdominal hysterectomy). |
| | Approach | Targeted surveillance |
| | Frequency of data submission | Quarterly |
| | Purpose(s) | Benchmarking between hospitals in a same group |
| | Number of participants | Total 402 hospitals, but most of hospitals do not submit all indicators. |
| | Strengths | – Hospital's performances are reported back to the hospitals which are comparable in each hospital group.<br>– There are statistic and academic consultation committee for indication selection; these lead to reliable information.<br>– THIP2 covers several types of hospitals (UHOSNET, private, public)<br>– Ensure quality of data due to having validation process |
| | Limitations | – There are a few participating hospitals in each group, so some indicators cannot comparable |

| Platforms | Key Profiles | Findings |
|---|---|---|
| | | among subgroup of hospitals.<br>– Selection bias should be concerned because most of participants are HA certificated hospitals.<br>– There is no AMR indicator.<br>– There is a registry cost in order to access database.<br>– There is no publicly report, though accessed by participating hospitals, benchmarking with other comparable hospital type |
| 7 GLASS (Thailand) | Host | DMSC |
| | Hospital key actor | ICNs<br>microbiological technicians |
| | Started since | 2016 |
| | Information collected | Proportion of AMR isolates in 8 pathogens<br>Frequency of AMR infection in 8 pathogens |
| | Frequency of data submission | monthly |
| | Approach | Case finding based on clinical specimens |
| | Purpose(s) | Global AMR monitoring with international peers organized by WHO |
| | Number of participants | 6 regional or provincial hospitals (including BIDI) with plans to expand coverage to 24 hospitals |
| | Strengths | – Combine patient clinical data and AMR laboratory data<br>– Global standard protocol<br>– High-quality laboratory<br>– Include both HAI, HAI referral cases from other hospitals, and CAI data |
| | Limitations | – Workload of ICNs for HAI and CAI diagnosis<br>– Workload to link data from separate hospital information systems (patient and lab data)<br>– Small sample size, but have a plan to implement in 24 hospitals<br>– Difference in HAI diagnosis applied |
| 8 Development of national AMR surveillance and response system (DeNARS) | Host | BOE |
| | Hospital key actor | ICNs, microbiological technicians, public health practitioners |
| | Started since | 2017 |
| | Information collected | Proportion of AMR isolates in 8 pathogens<br>Frequency of AMR infection in 8 pathogens |
| | Approach | Case finding based on clinical specimen |
| | Frequency of data submission | monthly |
| | Purpose(s) | AMR monitoring<br>Extend GLASS for more comprehensive data |
| | Number of participants | Pilot study in 6 hospitals |
| | Strengths | – Combine patient data and AMR data together<br>– More comprehensive information than GLASS e.g. nationality, occupation, patient outcome, refer |

| Platforms | Key Profiles | Findings |
|---|---|---|
| | | info, ward type, etc. |
| | Limitations | – Workload of ICNs for HAI and CAI diagnosis<br>– Workload to link data from separate data systems (patient and lab data) |
| 9 AMR case report | Host | BOE |
| | Hospital key actor | ICN, public health practitioner |
| | Started since | 2017 |
| | Information collected | Highly pathogenic AMR (VRSA, VRE, Colistin resistance A. baumannii, colistin resistance P. aeruginosa, 3rd cep-resistance N. gonorrhoeae) |
| | Approach | Case base surveillance |
| | Frequency of data submission | Report to BOE 7 days after diagnosis |
| | Purpose(s) | Alert system for rare case of AMR pathogens |
| | Number of participants | – Pilot study in 6 hospitals<br>– BOE is preparing the system for nationwide implementation, in line with the Communicable Diseases Act. |
| | Strengths | – Will be implemented nationwide for AMR alert system<br>– These AMR pathogens will be announced to be dangerous communicable diseases under the Communicable Disease Act 2015. |
| | Limitations | – Paper based submission<br>– Monitor only five highly pathogenic organisms, not represent overall AMR morbidity |

Data sources: PPS on HAI[12–15], NARST[16], Service plan AMR indicator[17], THIP2 (IC module)[18], GLASS[5], other information is from key informants.

Figure2: depicts different actors, the current systems of data flows at hospital and national level



## 3. AMR data management in Thai hospital context

### Key findings

- AMR data composes of two components which are clinical data and microbiological data. Both components originate from different departments in a hospital. Hospital's key players who are responsible for AMR data are ICNs and lab scientists.
- At hospital level, usages of AMR data are for two purposes consisting of 1) use as alert system for prevention of AMR transmission across patients and between health workers and patients, 2) monitor the IPC and clinical practices in each ward along with HAIs monitoring.
- Some information cannot be exported directly by hospital database; these still need to be diagnosed, verified and confirmed by ICNs or ID doctors, for example, 1) to differentiation between HAI, CAI, or HAI referral cases from other hospitals, 2) to identify and exclude the contamination of specimens or colonized pathogen.
- According to ICD-10 TM version 2016, there are AMR codes - U81-U83; however, these are not practically used in a reimbursement process by the three public health insurance systems. (see annex 3). Therefore there is no AMR data entry.
- In the 72nd World Health Assembly, ICD-11 will be endorsed which there are AMR codes – MG50 -MG5Z. These codes are more comprehensive than ICD-10. (see annex 4). This furnishes an opportunity for maximize use for AMR case base reporting and integration into national health information systems.

## 4. Challenges of AMR data system

### 4.1 Local/hospital level

- Linkage of microbiological information and clinical information is a challenge in most hospitals, especially in public hospitals, because the linkage of both databases in particular when most of MOPH laboratory acquires free software for public hospitals—which facilitate service provision, but not for linking laboratory with clinical data. Such linking with clinical database requires an additional payment to program venders.
- In district hospitals, patients' specimens for culture and sensitivity tests are sent to a referral laboratory in the province, either public or private laboratory, for investigation. Although the results are reported back, officially in PDF form which does not facilitate electronic recording in the hospital laboratory database; further data entry manually is needed which may introduce human errors and delays.
- To submit data to the national level, either raw data or secondary data, are submitted by local healthcare facilities' staff. Each of the nine platforms in Table 3, has its individual data entering formats resulting in additional workloads to the already constrained staffs, mostly ICN and Laboratory Scientists.
- Although there is laboratory accreditation system, microbiological capacities are limited in some hospitals e.g. colistin susceptible test, MIC test, CLSI standard, etc. Therefore evidence of susceptibility to these antibiotics are lacking reliable results in certain hospitals.
- There are limited health workforces either ICNs or lab scientists compared with heavy workloads on their routine responsibility. It jeopardizes the quality, reliability and completeness of surveillance; though certain hospitals opt for targeted surveillance. Target surveillance means selective of certain conditions of their concern such as sepsis, ventilator associated pneumonia or catheter associated urinary tract infection.

- The sense of system's ownership is low among several hospitals' staffs, they feel these additional works are not beneficial to their routine practices. These could have negative impacts on data quality, accuracy and completeness.

### 4.2 National level

- Clearly, there are several MOPH's organizations played active roles and had shown commitment on AMR and HAIs surveillance system; however, there is a lack of leadership to direct and oversight, harmonize, ensure quality through verification, and maximize use of HAI and AMR information system for monitoring and for policy decisions. This results in separate AMR surveillance tools developed by each agency.
- Despite large number of AMR and ID experts in Thailand, there is no single centrally pooled AMR database for which any AMR-related organizations can directly use and analyze for policy purpose.
- The critical challenge is country's health information system which lacks the health data standard, personal health record system, and information exchange platform. MOPH has yet to play its leadership role to overcome these critical problems. Challenges in HAI and AMR morbidity is a tip of iceberg of large challenges in hospital information systems.

## Part 3: Recommendations

**1 Overall recommendations**

a. In effective response to AMR challenges, Thailand cannot afford to have nine platforms for HAI/AMR monitoring. There is a need to harmonize all of these into a national platform which can contribute to 1) estimate the annual incidence of HAI and AMR both case-base and laboratory-base, 2) produce these evidence in a timely manner for effective and immediate response by individual hospital such as actions towards outbreaks and improve their IPC performance; 3) national monitoring of AMR morbidity as mandated by NSP AMR; 4) annual publication on the prevalence of HAI and AMR morbidity and antibiograms for consumption by the health professional communities and for general public to increase AMR awareness; and report to the National Steering Committee on AMR.

b. To achieve these four objectives; a prospective hospital-wide, case-base and lab-base, HAI /AMR surveillance should be applied in certain public and private sentinel sites; the number of sites should be adequate enough to representing Thailand. These sentinel hospitals should have high qualified laboratory capacities. Validation of submitted data is mandatory required. Hospitals outside sentinel sites can voluntary monitor their own HAI and AMR with timely local responses. There is a need to strengthening health information system at hospital level which facilitates linkage between laboratory and clinical data systems.

c. Advantages: this approach will minimize local health workers' workload, which improve the completeness, accuracy and reliability of data submission. Feedback loops and technical supports are essential to gain collaboration from sentinel hospitals

**2 Recommendations for existing AMR information tools**

Table 4: recommendations for each platform

| Platforms | Recommendations |
|---|---|
| 1.Hospital's routine HAI surveillance | This is a routine and voluntary work by hospital to monitor the outcome of their IPC practices. This platform is a backbone of HAIs prospective surveillance system. No matter the hospital is part of the national sentinel sites or not, there must be this platform. Information from this could be used for both national (if they are part of the sentinel sites) and hospital own monitoring. |
| 2 BIDI's prospective HAI surveillance | This is the platform of prospective case bae HAI surveillance which covers the largest number of hospitals in Thailand. There are also lab-based AMR data collected in this platform (though initiated recently).<br><br>The platform can contribute to the estimate of 2017 baseline incidence of HAI and AMR morbidity as required by NSP-AMR and progress in 2018 and subsequent years. However, it is noted that this platform does not cover CAI, hence the AMR morbidity is slightly under-estimated.<br><br>Comparing with eight other platforms; this has the highest potential to transform to the National AMR surveillance |

| Platforms | Recommendations |
|---|---|
| | fulfilling the recommendations; though there is a need for a significant upgrade and improvement for user friendly software and submission processes, validation and feedback loop and publication, capacities and resources in the BIDI as a host agency. |
| 3 PPS on HAI | PPS has its advantage to evaluate the accuracy of a routine HAIs surveillance system while the local ICNs always conduct regular PPS as their routine work annually.<br><br>This platform should be continued as a national survey every 3 years though the PPS needs to apply the modified ECDC PPS protocol convened by IHPP in 2018. Results from PPS can be rechecked and compared with the result from prospective surveillance. |
| 4 NARST | NARST has been conducted with a large number of surveillance sites for a long time. This is also a backbone of lab-based AMR information in Thailand. It generates antibiogram on percent susceptibility of key pathogens and key antibiotics at national and 12 public health regions.<br><br>Although there are rapid increases in number of participating hospitals, laboratory quality is a concern. Along with encouraging hospital to submit their data, capacity building and accreditation of microbiological lab should be a one of mile stone to achieve.<br><br>To maximize use NARST, DMSC need to share this information with Health Administration Division (HAD) of the MOPH to use this database for monitoring hospital performance on AMR practices, and also the hemoculture and sensitivity test for the KPI of all general and regional hospitals. |
| 5 Service plan AMR indicator | This AMR indicator is one of the KPI collected by HAD; there are other indicators reported by local AMR focal points.<br><br>To decrease workloads, the HAD should use DMSc's NARST data to monitor AMR performance in each hospital and report the result back to the hospital, not only cover sepsis but all other infection sites. There is no need to submit primary data from local health worker separately.<br><br>This platform can be curtailed; with two options: a) HAD maximizes use of data from NARST to monitor the KPI of general and regional hospital, b) NARST produces annual report by individual general and regional hospitals. |
| 6 THIP2 (IC module) | THIP2 is a voluntary and reliable benchmarking platform among members who submit data with security of access. Its data entering is simple. However, its data source is similar to the |

| Platforms | Recommendations |
|---|---|
| | BIDI's HAI surveillance system. To avoid additional workloads, data sharing from BIDI's database would be helpful.<br><br>The Healthcare Accreditation Institutes should reconsider if primary data collection from voluntary hospitals is still required, the strengths of BIDI's prospective HAI surveillance is its larger sample size than the voluntary accredited hospitals. |
| 7 GLASS (Thailand) | DMSC may need to reconsider not to expand GLASS sites to 24 hospitals nationwide. Data mining from existing databases is the way to avoid primary data collection by local staffs. Such linkages of case-based and laboratory based can fulfill commitment to WHO GLASS with more cost-effective approach.<br><br>There are two main data used in GLASS, consisting of lab result and patient data. DMSC should combine secondary data from NRAST and HDC database. This can release the burden of data submission. It is noted that a personal unique identification number (the 13 digits Citizen ID number) is a key to link the two databases.<br><br>It is also noted that GLASS is another possible approach to generate the incidence of AMR baseline data in 2017 and outcome in 2018 using NARST and HDC database. However, the challenge is lack of NARST's citizen ID number which is a key to interface the two databases (HDC and Lab findings). |
| 8 Development of national AMR surveillance and response system (DeNARS) | DeNARS extends GLASS method to collect more information. Similar to GLASS. DeNARS should curtail and avoid primary data collection by hospitals. BIDI's prospective HAI / AMR surveillance and NARST can fulfil the mandates by the Bureau of Epidemiology |
| 9 AMR case report | AMR case report has its specific purpose for flagging national alert system of the emergence of highly pathogenic organisms which become resistance to antibiotics.<br><br>Currently the IT at individual hospital laboratory has already in good function (using Pop Up and LINE communication even between district and provincial hospitals and within hospitals) which trigger local responses to clinicians and ICN, The BOE can apply the existing trigger systems to the national level instead of paper-based report by hospitals. |

**3 Information needed for the BIDI's prospective HAI/AMR surveillance and NARST**

3.1Target population

- The surveillance should focus initially on inpatients because most of AMR affected patients were hospitalized; and less likely that outpatients are affected by AMR

- Ideally, the surveillance should cover both community acquired infection and hospital acquired infection. If the system collected only HAIs data, the number of overall AMR incidence would be underestimation. There are two AMR markers which are not a HAIs pathogen, this includes Streptococcus pneumoniae, and Neisseria gonorrhoeae. Gonorrhoeae are usually treated by private sector or by STI hospitals (Bangrak hospital)

3.2 AMR markers

- AMR markers should cover the nine priority pathogens listed in the NSP-AMR 2017-2021 which were selected by a group of Thai ID experts (see table 5). However, this list should be updated regularly in view of emergence of new pathogens.
- Most of existing international literatures report AMR burden by pathogen which is useful for clinical interventions. Nonetheless, to monitor this at national level, an overall AMR burden measured by number of patients affected, and its economic consequences are more important for policy makers to commit to actions. It is suggested by this study that AMR report should cover both case based morbidity and laboratory based pathogen and susceptibility profiles.

Table 5: AMR markers monitored in the NSP-AMR 2017-2021

| **Pathogens** | Carbapenems | Colistin | 3rd gen. cephalosporin | Fluoroquinolones | Vancomycin | Penicillin | Methicillin [MRSA] |
|---|---|---|---|---|---|---|---|
| 1. Acinetobacter spp | X | X | | | | | |
| 2. Pseudomonas aeruginosa | X | X | | | | | |
| 3. Klebsiella pneumonia | X | X | X | | | | |
| 4. Escherichia coli | X | X | X | X | | | |
| 5. Salmonella spp. | | X | X | X | | | |
| 6. Enterococcus | | | | | X | | |
| 7. Streptococcus pneumoniae | | | X* | | | X | |
| 8. Staphylococcus aureus | | | | | X | | X |
| 9. Neisseria gonorrhoeae | | | X** | | | | |

Note: * only ceftriaxone or cefotaxime, ** only cefixime
Data source: the NSP-AMR 2017-2021[3]

3.3 Indicators

- To monitor AMR morbidity, not only microbiological and susceptibility profiles are required, patient information are essential.
- There are many indicators used for AMR monitoring; most of them are proportion of resistant isolates (see table 6).
- To monitor AMR morbidity, the monitoring indicator is the AMR annual incidence per 100 admissions. The numerator should be the number of AMR patients without duplication while a denominator can be several variables, including
    - population covered by participating site,
    - total number of admissions (this is used for inpatients), or

- total number of specimen-submitting patients.
- However, the preferred indicators are proposed in table 7.

Table 6: AMR indicator used in each monitoring system

| Tools | Indicator reported | Numerator | Denominator |
|---|---|---|---|
| 1 GLASS | Proportion of resistant isolates | AMR samples | positive culture specimens |
| | Incidence of AMR in 100,000 tested patients | AMR patients | specimen-submitting patients |
| 2 JANIS | Incidence of AMR in all tested patient | AMR patients | specimen-submitting patients |
| 3 AMR service plan program* | Incidence of AMR in all tested patient | AMR patients | specimen-submitting patients |
| 4 EARS-net | Proportion of resistant isolates | AMR samples | positive culture specimens |
| 5 CAESAR | Proportion of resistant isolates | AMR samples | positive culture specimens |
| 6 NARST | Proportion of resistant isolates | AMR samples | positive culture specimens |
| 7 NHSN-AUR module | Proportion of resistant isolates | AMR samples | positive culture specimens |
| 8 ECDC-PPS on HAIs | Proportion of resistant isolates | AMR patients | positive culture specimens |
| 9 Global-PPS** | Prevalence of patient used ATB for AMR in total treated patient | Patients used ATB for AMR | Patients using ATB for treatment |

Note: * report percentage by all AMR organisms and by each organism, ** report percentage by all AMR organisms, not separately report by each organism

Data sources: GLASS[5], JANIS[11], AMR service plan indicator[17],EARS-Net[10], CAESAR[9], NARST[16], US-CDC[8], ECDC-PPS[6], the Global-PPS[7]

Table 7: Proposed key indicators and related parameters

| Indicators | Numerator | Denominator |
|---|---|---|
| 1. HAI annual incidence, % of total admissions | Number of inpatients diagnosed as HAI which fulfill clinical criteria in a year | Total number of admissions in a year |
| 2. AMR annual incidence, % of total admissions | Number of inpatients with lab confirmed AMR in a year | Total number of admissions in a year |
| 3. Proportion of AMR in HAIs, % | Number of HAI patients with confirmed AMR in a year | Total number of patients with HAIs in a year |

**4 Short term actions by 2019**

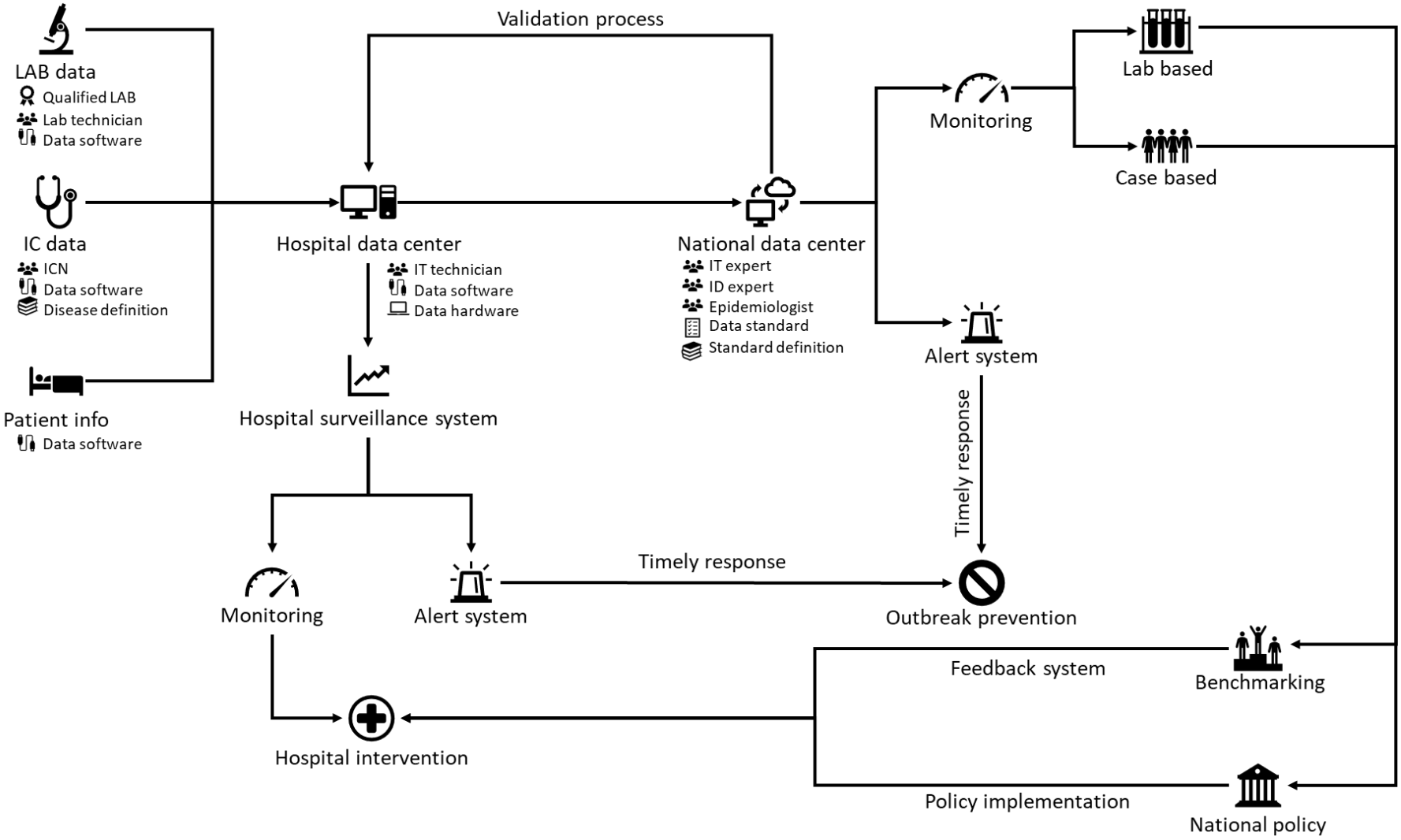
- For documenting baseline incidence of AMR morbidity in 2017 and progress in 2018; there are two feasible ways to retrospectively estimate from the existing databases.
  - Verify, validate and analyze BIDI's database using data from only hospitals providing complete hospital wide data, exclude data from hospitals conducting targeted surveillance.
  - Combine NARST and HDC databases, and analyze based on GLASS approach
- Strengthen BIDI's HAIs surveillance as proposed
- Strengthen NARST by linking with the MOPH existing HDC databases and contribute to GLASS while avoid additional workload of local staffs

- Consider curtailing other less relevant platforms which can excerpt data/evidence from BIDI's prospective HAI/AMR surveillance and NARST

**5 Medium term plan by 2020:**

- Streamlining reporting of HAIs and AMR, both clinical and lab based
    - Keep and strengthen BIDI's HAIs as national HAI/AMR morbidity surveillance systems, simplified GLASS, and NARST are the key national platforms which serve national policy.
- Strengthening health information system to support AMR surveillance by integrating microbiological data such as that produced by M lab, WHO Net with HDC database. This would be a long-term and sustainable and cost-effective solution.
- Modifying BIDI's platform to collect HAIs and AMR related mortality data and its economic impacts. This requires research to estimate the AMR Population Attributable Factor which contribute to mortality in Thai population.

Figure 3: Framework of national AMR monitoring in human



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## Annex 1: Interview guideline

Questions for hospitals and Ministry of Public Health personnel

1. Information system that related to AMR that is being used at present, if there are several systems, ask about all systems
    a. Method of data collection
    b. Types of data that have to be collect and details, i.e. patient's information, laboratory result data
    c. Definition of infection and definition of AMR that are used in data collection
    d. Data validation
    e. Linkage between each information systems, i.e. data transmission between each program to reduce duplication
    f. Responsible persons for AMR data and their existing workload
    g. Support from the executives and external organization on budget, capacity, equipment and knowledge
    h. Use of data in hospitals and national level
    i. Problems and obstacles of data collection and data analysis
    j. (For Ministry personnel) number of participating hospitals, future plan on system development
2. Suggestions for data collection to monitoring AMR infection in the future
    a. Expected data collection format
    b. Information that needs to be used
    c. Key success factors of data collection

Questions for infectious disease experts

1. Assessment of AMR morbidity
    a. Appropriate indicators for assessment of AMR morbidity
    b. Definition of hospital associated infection and AMR that suitable for Thailand
    c. AMR marker that need to be followed
2. Opinion on previous and existing AMR data collection systems in Thailand
    a. Use of data on national level and hospital level
    b. Reliability of the data.
    c. Strength and development of data collection system
3. Suggestion for data collection to monitoring AMR infection in the future
    a. Expected data collection format
    b. Information that needs to be used
    c. Key success factors of data collection

Questions for information system experts

1. Health information system in Thailand
    a. Overview of health information system in Thailand.
    b. Strength and challenges of current data collection system
2. Suggestion for data collection to monitoring AMR infection in the future

a. Data collection format that suitable for Thailand
b. Data management and governance
c. Key success factors of data collection

Questions for laboratory and hospitals data venders

1. Laboratory data or hospital data system that are under supervision.
    a. Overview of data system that being supervised by the company, i.e. types of data that are under supervision, number of participating hospitals.
    b. Recorded data about AMR (If any)
    c. Existing data management systems
    d. Link between other data systems and its problems
    e. Services that the company provides to the customers, i.e. use of data, open to opinions, software updates
    f. Strength and challenges of current data collection systems

## Annex 2: Summary of key issues from the consultative meeting

**"System analysis for AMR morbidity monitoring in Thailand: Challenges and solutions"**

**On March 4th, 2019 at Morakot room, Bamrasnaradura Infectious Disease Institute**

**List of participants**

| | | |
|---|---|---|
| 1 | Dr.Surtya Wongkongkathep | Antimicrobial Resistance AMR |
| 2 | Dr.Viroj Tangcharoensathien | International Health Policy Programm |
| 3 | Dr.Kumthorn Malathum | Faculty of Medicine Ramathibodi Hospital, Mahidol University |
| 4 | Dr.Krisada Hanbunjerd | Bamrasnaradura Infectious Diseases Institute (BIDI) |
| 5 | Dr.Weerawat Manosuthi | Bamrasnaradura Infectious Diseases Institute (BIDI) |
| 6 | Dr.Visal Moolasart | Bamrasnaradura Infectious Diseases Institute (BIDI) |
| 7 | Dr.Richard Brown | WHO Thailand |
| 8 | Dr.Phiangiai Boonsuk | WHO Thailand |
| 9 | Mr.Somsak Rahule | M Lab program |
| 10 | Mr.Traithep Fongthong | National Health Security Office |
| 11 | Dr.Thitipong Yingyong | Bureau of Epidemiology Department of Disease Control |
| 12 | Ms.Noppavan Janejai | National Institute of Health of Thailand |
| 13 | Dr.Wantana Paveenklttiporn | National Institute of Health of Thailand |
| 14 | Ms.Amornrat Vijitleela | Department of Medical Services |
| 15 | Ms.Sukanya Numsawat | Food and Drug Administration |
| 16 | Ms.Raththar Benchapalanont | Food and Drug Administration |
| 17 | Dr.Sang Usayaporn | Faculty of Pharmaceutical Sciences, Chulalongkorn University |
| 18 | Ms.Kanokporn Thongphubeth | Thammasat University Hospital |
| 19 | Ms.Narlssara Mungkornkaew | Thammasat University Hospital |
| 20 | Ms.Chonlada Piwpong | Surat Thani Hospital |
| 21 | Ms.Natthiya Inthachang | Surat Thani Hospital |
| 22 | Ms.Darat Ruangkriengsin | Sakaeo Crown Prince Hospital |
| 23 | Ms.Chonnisa Kaeoviset | Sakaeo Crown Prince Hospital |
| 24 | Ms.Mujarin Jamsangtong | Prapokklao Hospital |
| 25 | Ms.Benjawan Nakornpat | Chumphon Khet Udomsak Hospital |

| | | |
|---|---|---|
| 26 | Ms.Kunyanut Payuk | Chao Phya Abhaibhubejhr Hospital |
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| 28 | Ms.Duangruethai Jankiew | Taksin Hospital |
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| 38 | Ms.Jitlada Rujitip | Bamrasnaradura Infectious Diseases Institute (BIDI) |
| 39 | Ms.Ampaiwan Puangkamyad | Bamrasnaradura Infectious Diseases Institute (BIDI) |
| 40 | Ms.Nattida Horharin | Bamrasnaradura Infectious Diseases Institute (BIDI) |
| 41 | Mr.Chumphae Somboon | Bamrasnaradura Infectious Diseases Institute (BIDI) |

**National AMR surveillance system**

Nowadays, many hospitals in Thailand have faced a problem of connecting the patient database system with the laboratory microbial culture database. As the Ministry of Public Health did not systematically work on health database, thus, forcing each hospital to develop their own system in which hospitals have to pay to connect each data system together. The Department of Medical Science (DMSc) is in the process of connecting the laboratory databases with MOPH 43 folders database; with the help of the Information Technology and Communication Center and other sectors, both government and private, which can be done technically, and the meeting agreed that this is an issue that should be dealt with. In addition, it is necessary to define the standard of microbiological data, the scope of information that needs to be collected, the method of data validation and designate a person responsible for maintaining the database systems systematically. Lastly, there is also suggestion to link the two systems together with the national 13 digits identification number.

Data collection of AMR has been collected separately which increases the workload for data collectors. Hence, the meeting agreed upon integrating all data collection together, by considering the purpose and benefits of each system and cutting redundant data collection. Suggested primary stage that system should be divided into two systems based on the origin of the data, which are ICN originated and Lab originated. However, the purpose of data collection and weakness of each method should also be considered. For example, GLASS data collection is for reporting the infection rate of the country that need a very precise data; thus, needs high quality laboratory. In contrast, NARST data

collection is for enhancing the potential of the laboratory; thus, the quality of the laboratory might not as high as those participated in GLASS.

**Management issues of AMR on the national level**

The main issue of AMR surveillance system in Thailand is the lack of leadership that can target and support this to work as a system. It is currently causing the works to be done separately, and also with lack of communication to frontline healthcare providers, it is causing the policy implementation a problem. The MOPH should consider having a responsible organization for this issue, or developing the existing organization to be able to take responsibility for AMR work on the national level.

**Appropriate data collection guidelines**

Using hospital wide prospective surveillance method in collecting data might not be the best method, as it requires large amount of resources and cannot be used to solve any specific problem. It can be seen in many hospitals that they will collect only targeted surveillance, and GLASS does not keep all AMR and does not collect data from every site infection. Moreover, data collection by site of infection can solve specific problems which occurred in the hospital and lead to problem solving process. Sensitivity analysis might have to be done to see the difference in the outcome from data collection by hospital wide and targeted surveillance methods. However, there is a suggestion for this issue that by collecting data using hospital wide in sentinel sites will increase the chance to get the complete overall data of the country. There are also suggestions to consider on the following issues for data collection system that will be developed:

1. Should include all types of hospital - all public hospitals and private hospitals
2. Consider the use of data at the healthcare facility level, which the data sender can use that data
3. Must have data validation process
4. At present, there is no data collection system that can collect AMR mortality data. Bamrasnaradura Infectious Disease Institute is currently developing their own data collecting system to collect this type of data.
5. Consider hospitals that are a part of Integrated AMR hospitals network in collecting data to make sure that it follows the same direction with the ongoing project

**Suggestions for future operations**

The operation on integrating data system and developing AMR surveillance should be done by the sub-committee 1 that is responsible for surveillance data - according to the resolution of national strategy committee which the DMSc is the secretary, presently planning on the development and will have a workshop to develop data collection guidelines together with related parties in May 2019.

**Other suggestion for the study's results.**

In this study, should develop thinking framework for AMR data collection in a national level before talking about technical issues, by developing from existing system and considering data needed to determine the policy. By having clear thinking framework will make the development of data collection system complete as needed, such as, how to collect data, what type of data to be collected, where to, what is redundant data and how can it be used.

This study should consider adding another type of data collection analysis by using ICD10. Even though there might be some limitation due to unable to precisely separate AMR as needed, but it can be used for the analysis of reliability and the benefits of data in each system can be used as a consideration

for integrating all data system together. Also, there should be suggestions on identifying the type of data that should be considered in the AMR mortality data collection.

At present, it is found that specimen collection system and microbiological examination system in hospitals are still problematic. The support of quality development of inspection should be emphasized, as it is important aspect for getting accurate data.

## Annex 3: AMR related codes in ICD10-TM

**U82 Resistance to betalactam antibiotics**

Use additional code (B95-B98), if desired, to identify agents resistant to betalactam antibiotic treatment.

U82.0 Resistance to penicillin

Resistance to:

- amoxicillin
- ampicillin

U82.1 Resistance to methicillin

Resistance to:

- cloxacillin
- flucloxacillin
- oxacillin

U82.2 Extended spectrum betalactamase (ESBL) resistance

U82.8 Resistance to other betalactam antibiotics

U82.9 Resistance to beta lactam antibiotics, unspecified

**U83 Resistance to other antibiotics**

Use additional code (B95-B98) if desired, to identify agents resistant to other antibiotic treatment.

U83.0 Resistance to vancomycin

U83.1 Resistance to other vancomycin related antibiotics

U83.2 Resistance to quinolones

U83.7 Resistance to multiple antibiotics

U83.8 Resistance to other single specified antibiotic

U83.9 Resistance to unspecified antibiotic

Resistance to antibiotic NOS

**U84 Resistance to other antimicrobial drugs**

*E.xcl.:* resistance to antibiotics (U82-U83)

U84.0 Resistance to antiparasitic drug(s)

Resistance to quinine and related compound

U84.1 Resistance to antifungal drug(s)

U84.2 Resistance to antiviral drug(s)

U84.3 Resistance to tuberculostatlc drug(s)

U84.7 Resistance to multiple antimicrobial drugs

*E.xcl.:* resistance to multiple antibiotics (U83.7)

U84.8 Resistance to other specified antimicrobial drug

U84.9 Resistance to unspecified antimicrobial drug

Drug resistance NOS

## Annex 4: AMR related codes in ICD11

**MG50 Finding of gram-negative bacteria resistant to antimicrobial drugs**

- MG50.0 Antibiotic resistant Acinetobacter baumannii
  - MG50.00 Tetracycline resistant Acinetobacter baumannii
  - MG50.01 Aminoglycoside resistant Acinetobacter baumannii
  - MG50.02 Carbapenem resistant Acinetobacter baumannii
  - MG50.03 Polymyxin resistant Acinetobacter baumannii
  - MG50.0Y Acinetobacter resistant to other antibiotic
  - MG50.0Z Acinetobacter resistant to unspecified antibiotic
- MG50.1 Antibiotic resistant Campylobacter
  - MG50.10 Fluoroquinolone resistant Campylobacter
  - MG50.1Y Other specified antibiotic resistant Campylobacter
  - MG50.1Z Campylobacter resistant to unspecified antibiotic
- MG50.2 Antibiotic resistant Escherichia coli
  - MG50.20 Sulfonamide or trimethoprim resistant Escherichia coli
  - MG50.21 Fluoroquinolone resistant Escherichia coli
  - MG50.22 Third generation cephalosporin resistant Escherichia coli
  - MG50.23 Fourth-generation cephalosporins resistant Escherichia coli
  - MG50.24 Carbapenem resistant Escherichia coli
  - MG50.25 Polymyxin resistant Escherichia coli
  - MG50.26 Penicillin resistant Escherichia coli
  - MG50.27 Extended spectrum beta-lactamase producing Escherichia coli
  - MG50.2Y Escherichia coli resistant to other antibiotic
  - MG50.2Z Escherichia coli resistant to unspecified antibiotic
- MG50.3 Antibiotic resistant Haemophilus influenzae
  - MG50.30 Ampicillin resistant Haemophilus influenzae
  - MG50.3Y Other specified antibiotic resistant Haemophilus influenzae
  - MG50.3Z Antibiotic resistant Haemophilus influenzae, unspecified
- MG50.4 Antibiotic resistant Helicobacter pylori
  - MG50.40 Clarithromycin resistant Helicobacter pylori
  - MG50.4Y Other specified antibiotic resistant Helicobacter pylori
  - MG50.4Z Antibiotic resistant Helicobacter pylori, unspecified
- MG50.5 Antibiotic resistant Klebsiella pneumoniae
  - MG50.50 Sulfonamide or trimethoprim resistant Klebsiella pneumoniae
  - MG50.51 Fluoroquinolone resistant Klebsiella pneumoniae
  - MG50.52 Third-generation cephalosporin resistant Klebsiella pneumoniae
  - MG50.53 Fourth-generation cephalosporin resistant Klebsiella pneumoniae
  - MG50.54 Carbapenem resistant Klebsiella pneumoniae
  - MG50.55 Polymixin resistant Klebsiella pneumoniae
  - MG50.56 Extended-spectrum beta-lactamase producing Klebsiella pneumoniae
  - MG50.5Y Klebsiella pneumoniae resistant to other antibiotic
  - MG50.5Z Klebsiella pneumoniae resistant to unspecified antibiotic
- MG50.6 Antibiotic resistant Neisseria gonorrhoeae

    - MG50.60 Third generation cephalosporin resistant Neisseria gonorrhoeae
    - MG50.61 Macrolide resistant Neisseria gonorrhoeae
    - MG50.62 Aminocyclitol resistant Neisseria gonorrhoeae
    - MG50.63 Fluoroquinolone resistant Neisseria gonorrhoeae
    - MG50.64 Aminoglycoside resistant Neisseria gonorrhoeae
    - MG50.6Y Neisseria gonorrhoeae resistant to other antibiotic
    - MG50.6Z Neisseria gonorrhoeae resistant to unspecified antibiotic
- MG50.7 Antibiotic resistant Neisseria meningitidis
    - MG50.70 Penicillin resistant Neisseria meningitidis
    - MG50.7Y Other specified antibiotic resistant Neisseria meningitidis
    - MG50.7Z Antibiotic resistant Neisseria meningitidis, unspecified
- MG50.8 Antibiotic resistant Pseudomonas aeruginosa
    - MG50.80 Carbapenem-resistant Pseudomonas aeruginosa
    - MG50.81 Polymixin-resistant Pseudomonas aeruginosa
    - MG50.8Y Pseudomonas aeruginosa resistant to other antibiotic
    - MG50.8Z Pseudomonas aeruginosa resistant to unspecified antibiotic
- MG50.9 Antibiotic resistant Salmonella
    - MG50.90 Fluoroquinolone resistant Salmonella
    - MG50.91 Third generation cephalosporin resistant Salmonella
    - MG50.92 Carbapenem resistant Salmonella
    - MG50.9Y Salmonella resistant to other antibiotic
    - MG50.9Z Salmonella resistant to unspecified antibiotic
- MG50.A Antibiotic resistant Shigella
    - MG50.A0 Carbapenem resistant Shigella
    - MG50.A1 Fluoroquinolone resistant Shigella
    - MG50.A2 Third-generation cephalosporins resistant Shigella
    - MG50.A3 Macrolides resistant Shigella
    - MG50.AY Shigella resistant to other antibiotic
    - MG50.AZ Shigella resistant to unspecified antibiotic
- MG50.B Antibiotic resistant Vibrio
    - MG50.B0 Fluoroquinolone resistant Vibrio
    - MG50.BY Vibrio resistant to other antibiotic
    - MG50.BZ Vibrio resistant to unspecified antibiotic
- MG50.C Other antibiotic resistant Enterobacteriaceae
    - MG50.C0 Carbapenem resistant Enterobacteriaceae
    - MG50.C1 Third-generation cephalosporin resistant Enterobacteriaceae
    - MG50.CY Other specified other antibiotic resistant Enterobacteriaceae
    - MG50.CZ Other antibiotic resistant Enterobacteriaceae, unspecified
- MG50.Y Other specified finding of gram negative bacteria resistant to antimicrobial drugs
- MG50.Z Finding of gram negative bacteria resistant to antimicrobial drugs, unspecified

**MG51 Finding of gram positive bacteria resistant to antimicrobial drugs**

- MG51.0 Antibiotic resistant Staphylococcus aureus
    - MG51.00 Methicillin resistant Staphylococcus aureus

    - MG51.01 Vancomycin resistant Staphylococcus aureus
    - MG51.02 Penicillinase-stable beta lactams resistant Staphylococcus aureus
    - MG51.0Y Other specified antibiotic resistant Staphylococcus aureus
    - MG51.0Z Antibiotic resistant Staphylococcus aureus, unspecified
- MG51.1 Antibiotic resistant Streptococcus pneumoniae
    - MG51.10 Penicillin resistant Streptococcus pneumoniae
    - MG51.11 Sulfonamide and trimethoprim resistant Streptococcus pneumoniae
    - MG51.12 Third-generation cephalosporins resistant Streptococcus pneumoniae
    - MG51.1Y Streptococcus pneumoniae resistant to other antibiotic
    - MG51.1Z Streptococcus pneumoniae resistant to unspecified antibiotic
- MG51.2 Antibiotic resistant Enterococcus
- MG51.Y Other specified finding of gram positive bacteria resistant to antimicrobial drugs
- MG51.Z Finding of gram positive bacteria resistant to antimicrobial drugs, unspecified

**MG52 Finding of bacteria, neither gram negative nor positive, resistant to antimicrobial drugs**

- MG52.0 Antibiotic resistant Mycobacterium
- MG52.Y Other specified finding of bacteria, neither gram negative nor positive, resistant to antimicrobial drugs
- MG52.Z Finding of bacteria, neither gram negative nor positive, resistant to antimicrobial drugs, unspecified

**MG53 Finding of virus resistant to antimicrobial drugs**

- MG53.0 Antiretroviral therapy resistant Human immunodeficiency virus
- MG53.Y Other specified finding of virus resistant to antimicrobial drugs
- MG53.Z Finding of virus resistant to antimicrobial drugs, unspecified

**MG54 Finding of fungus resistant to antimicrobial drugs**

**MG55 Finding of parasite resistant to antimicrobial drugs**

- MG55.0 Artemisinin resistant Plasmodium falciparum
- MG55.Y Other specified finding of parasite resistant to antimicrobial drugs
- MG55.Z Finding of parasite resistant to antimicrobial drugs, unspecified

**MG56 Finding of microorganism resistant to other multiple antimicrobial drugs**

**MG5Y Finding of other microorganism resistant to antimicrobial drugs**

**MG5Z Finding of microorganism resistant to antimicrobial drugs, unspecified**