HEALTH PROMOTION AND DISEASE PREVENTION **A Handbook for Teachers, Researchers, Health Professionals and Decision Makers**	
Title	**Epidemiological Surveillance and Control of Communicable Disease: Basis for Evidence Based Health Promotion and Early Response - Practical Perspective**
Module: 5.1	**ECTS: 0.5**
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Key words	Population surveillance, communicable disease control organization & administration
Learning objectives	After completing this module students and public health professionals should be: • aware of recent developments in national legal requirement for communicable disease surveillance and control; • recognise the scope and scale of development needed; • understand the link between public health practice and management sciences.
Abstract	The adoption by WHO's member states of the International Health Regulations (2005) represents a paradigm shift away from mandatory reporting of specific diseases to a requirement for ministries of health to notify WHO concerning any potential Public Health Emergency of International Concern (PHEIC). The European Union (EU) has also issued legislation on CDS&C, epidemic early warning and response, bioterrorism, and large number of related fields, including food safety, water quality, zoonotic diseases, blood safety, border controls, data protection and confidentiality etc, that are binding on EU member states. Harmonisation of national public health legislation to this acquis communautaire is a requirement for accession to the EU. This paper reviews the key guidance on strengthening CDS&C systems to meet the IHR and EU requirements, and it attempts to give a brief overview of international resources and implementation activities. If WHO member states are to respect the deadline of 2012 for achieving the stated IHR minimum core capacities, significant domestic investment will also be required, particularly for laboratory strengthening. Furthermore, Field Epidemiology Training Programmes and laboratory scientist training schemes will need to be established within the context of attractive careers in public health.

Teaching methods	Review paper of current state of the art.
Specific recommendations for teachers	100% individual students' work.
Assessment of students	Could be assessed by the quality of proposals and plans for strengthening CDS&C that result.

EPIDEMIOLOGICAL SURVEILLANCE AND CONTROL OF COMMUNICABLE DISEASE: BASIS FOR EVIDENCE BASED HEALTH PROMOTION AND EARLY RESPONSE - PRACTICAL PERSPECTIVE

Rob Stevens

Introduction

Surveillance provides health intelligence to health protection systems, which are the foundation for health promotion. The need for health intelligence has never been greater: good communicable disease surveillance and control (CDS&C) has already limited the spread of avian influenza, it helps to prevent a pandemic of human influenza, and even if that is not possible, it may provide sufficient early warning to slow down global spread, giving time to implement measures that could save millions of lives[1]; and good public health practice appears to have eliminated the new disease of SARS[2]. Strengthening of surveillance systems is necessary, however, to sustain successes and, for instance, to detect deliberate release of biological agents against the background 'noise' of endemic disease[3], and to institute second generation surveillance for HIV/AIDS.

The adoption by WHO's member states of the International Health Regulations (IHR) 2005 represents a paradigm shift away from mandatory reporting of three named diseases to a requirement for ministries of health to consult WHO concerning any health-related event that may pose serious international risk.

The European Union (EU) has also issued legislation on CDS&C, bioterrorism, and large number of related fields, including food and water quality, zoonotic diseases and blood safety, that are binding on EU member states. Harmonisation of national public health legislation to this *acquis communautaire* is a requirement for accession to the EU. Accession programmes in South-Eastern Europe have had a considerable impact of surveillance system strengthening.

This chapter reviews the key guidance on strengthening CDS&C systems to meet the IHR and EU requirements, and it attempts to give a brief overview of international resources and implementation activities. The promotion of health can be understood in at least two senses: 1) advocating for conditions and values in society that tend to improve population health; or 2) improving the health and wellbeing of individuals by encouraging them to have positive attitudes and behaviours. Strengthening surveillance contributes to both understandings by, in the first case, providing evidence of the need to maintain and improve traditional public health interventions such as sanitation, clean water and vaccination; and in second, yielding persuasive information on risk, and the effectiveness of both protective factors themselves and their communication to the public.

Concepts and Definitions

CDS&C is a cornerstone of public health, which is:

'The science and art of preventing disease, prolonging life and promoting health through the organised efforts and informed choices of society, organisations, public and private, communities and individuals.'[4]

This definition comes from a Ministry of Finance report that puts forward evidence-based arguments for substantial increases in multi-sectoral spending on health as a cost-effective

means of improving both individual prosperity and national productivity. This represents one of the few occasions since the post World War-II expansion of welfare systems in both communist and capitalism countries that investments in health have been recommended as good economics. Such arguments are particularly relevant right across WHO's European Region, where there is a strong and direct relationship between gross domestic product (GDP) and the percentage of GDP spent on health. On average, in countries which have a smaller 'cake', the health sector also gets a smaller cut of this cake. This relationship can be easily verified by plotting national wealth against health expenditure indicators oneself from the WHO European Health For All database[5].

Surveillance creates health information that contributes to national and international databases[5,6,7,8], which are important sources for advocating for increased health resources at national level. But it can be differentiated from other types of regular statistical reporting by the fact that it is set up for the main purpose of vigilance for alert conditions, such as outbreaks of communicable disease, or unexpected changes in the occurrence rates of chronic diseases. Vigilance for the unexpected often requires interpretation and judgement – epidemic intelligence[9] – which is conceptually distinct from simple monitoring of expected results within a statistical normal range. Surveillance is itself an 'open' system, i.e. open to alert signals coming from the wider environment which do not have to be completely defined *a priori.* However, most systems contain 'closed' systems of monitoring health-related event reports against a statistically defined threshold. The clinical specialty of anaesthetics provides a good analogy. The anaesthetist monitors the patient's blood gas levels and regulates artificial ventilation in order to keep them within the normal range; whereas he or she is vigilant for electrocardiographic signs of arrhythmia, making an emergency response if necessary.

> Public Health Surveillance (PHS) can be defined as:
> 'The ongoing, systematic collection, analysis, interpretation, and dissemination of data about a health-related event for use in public health action to reduce morbidity and mortality and to improve health' [10]

Its main functions include supporting case detection and public health interventions, estimating the impact of a disease or injury, portraying the natural history of a health condition, determining the distribution and spread of illness, generating hypotheses and stimulating research, evaluating prevention and control measures, facilitating planning and detecting outbreaks of communicable diseases. The characteristic that PHS is 'ongoing', often over a period of many years, means that it is particularly suited to tracking trends and advocating increase and/or reallocation of resources for public health. It is clearly differentiated from one-off pieces of research, which must be justified according to the precise state of knowledge applying at the time of proposal.

The characteristic that PHS relates to data 'about a health-related event' means that surveillance entails a broad range of sources of information, not just official notification of disease occurrence. Sources include various levels within the 'clinical iceberg' from asymptomatic infection or pre-morbid pathology through presentation to clinical services, diagnostic confirmation and treatment, to death; the prevalence of risk and protective factors; the effectiveness of modifying conditions such as susceptibility to pharmaceutical treatment, efficacy of vaccination and impact of health promoting policy; and signals that are of use in early warning such as symptoms, syndromes, drug sales, rumours and media reports (the latter

being the subject of the WHO GPHIN[11]). The broad scope of surveillance gives opportunities for triangulation of data sources, and interpretation should be carried out by specialists with a broad awareness of general public health practice.

The characteristic that it is 'for use in public health action' designates its purpose as response – either acute (epidemic-type) or planned (management-type) – and this has led some countries to institutionalise PHS of biological, chemical, radiological and nuclear threats within a named 'health protection' system[12]. Viewing surveillance as part of a national health protection system implies that surveillance should 1) yield information relevant to the national capacity for public health action, such as food safety inspectorates, water quality assurance, vaccination coverage and disease control programmes, and 2) its impact should be assessed not only at the level of outcome (attributable reductions in morbidity and mortality); but also process, in terms of its successful advocacy for improvements in capacity for action. The impact of surveillance information on food borne diseases could, for instance, be evaluated in terms of numbers of successful applications of food safety legislation.

The characteristic that PHS is 'systematic' refers to the fact that information is produced by planned, orderly, systems which are 'human organisations of interacting components, which are carriers of numerous complex operating procedures and organisational structures[13]. A surveillance system may therefore be thought of as a dedicated human and technological resource set up primarily for gathering intelligence for health protection, disease prevention and bio-security. This intelligence contributes to the broader enabling process of changing or coping with the environment, which is defined as health promotion in the Ottawa Charter[14]:

> 'Health promotion is the process of enabling people to increase control over, and to improve, their health. To reach a state of complete physical, mental and social well-being, an individual or group must be able to identify and to realize aspirations, to satisfy needs, and to change or cope with the environment. Health is, therefore, seen as a resource for everyday life, not the objective of living. Health is a positive concept emphasizing social and personal resources, as well as physical capacities. Therefore, health promotion is not just the responsibility of the health sector, but goes beyond healthy life-styles to well-being.'

PHS enables people themselves to take better control of their health by providing accurate risk information and health education messages; and it enables policy makers to advocate for resources and allocate them optimally for preventing disease, prolonging life and promoting positive health.

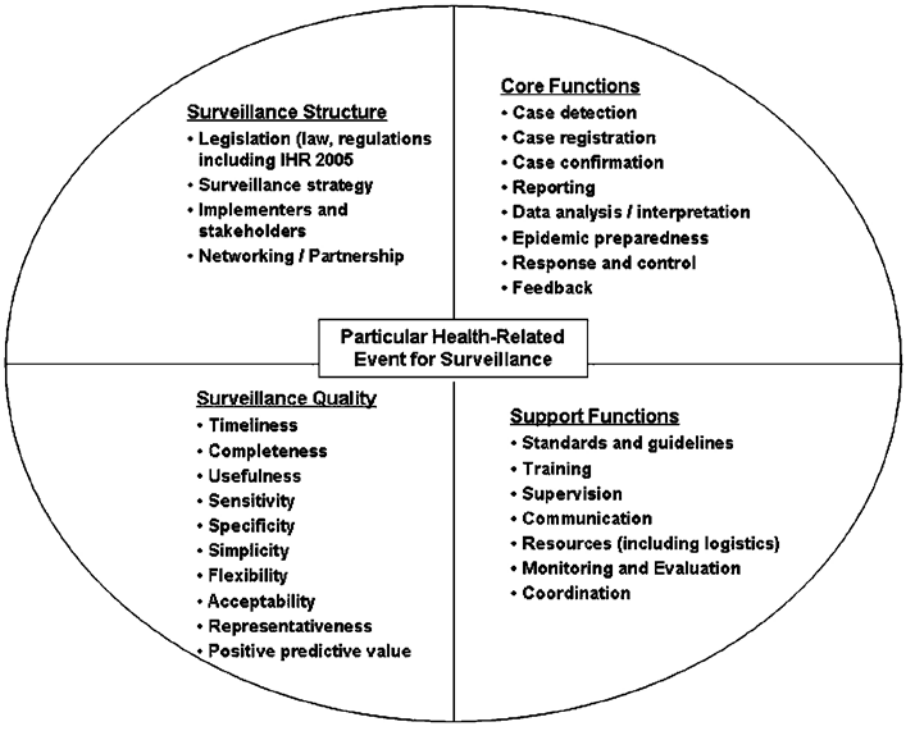
As well as having a broad range of sources of data, an optimal system for a particular health-related event tends to contain a mix of surveillance types. These types include, in order of increasing specialisation: syndromic surveillance; active data collection (contrasted with passive notification); enhanced surveillance; sentinel networks; planned, repeated, standard surveys of risk groups, e.g. behavioural surveillance of groups at high risk of HIV. Syndromic surveillance refers to the reporting of cases which meet a definition based solely on clinical symptoms and signs, not laboratory confirmation. The advantages of syndromic surveillance (e.g. for sexually transmitted diseases)[15] include: gaining information where laboratory confirmation is not available or affordable; improving sensitivity at the expense specificity in order to estimate overall burden of illness; and widening the population base for early warning. It also has clear application in detecting unusual health-related events which may be

of unkown cause, such as may occur in bioterrorist attacks. In active surveillance, the registry actively contacts practitioners, requesting them to provide information in a standard form on any cases which meet a case definition. Surveillance of the congenital rubella syndrome by paediatric professional societies[16] is a good example of this. Enhanced surveillance refers to combining extra information with the data required by statutory notification, such as case based information on risk-group membership, route of infection, markers of recent infection etc., or organism related information such as anti-microbial susceptibility. Sentinel surveillance refers to the designation of a sub-population for surveillance in which evidence of infection can provide early warning of a threat to wider populations. Examples include the use of 'sentinel chickens' for sero-surveillance of some vector borne viral diseases[17], and primary health care networks for early warning and intensity prediction of seasonal influenza epidemics[18]. The use of the word 'sentinel' is a military metaphor, a sentinel is a look-out who watches for approaching enemies in order to alert defence to the urgent need for action. The best known example of planned, repeated, standard surveys of risk groups is second generation surveillance of HIV/AIDS[19,20,21]. Repeated standard surveys are difficult to institutionalise because they require dedicated resources and project management capacity, competing with other priorities in ministries' annual plans. In order to be approved as projects, they are usually required to have statistical power similar to that of epidemiological research.

The essential feature of any system for detecting outbreaks of CD is the ability to determine epidemiological linkage. The daily or weekly occurrence of sporadic cases may fluctuate and unless they can be linked in person, place and time, outbreak investigation is unlikely to be fruitful. The majority of outbreaks come to light because an unusually large number of cases present to clinical services over a short time, raising suspicion. It is important therefore to scan local media for reports of outbreaks that may not have been notified to the proper authorities. Where a disease is more widespread in the population, or an outbreak develops over a long time-scale, epidemiological linkage can usually only be detected through case-based electronic registers.

Figure 1 presents WHO's conceptual framework for communicable diseases surveillance, which was first described in 2002[22] and continues to be elaborated through a series of guidance documents[23,24,25] issued by WHO/CSR office in Lyon[26] (for a summary of the activities of this office see reference aa). It contains four domains, describing a set of 29 topics in total, each of which can be represented by one or more indicators defined at the national level[24]. The domains define the organisation and performance of a system for the surveillance of a particular health-related event in terms of its structure, core and support functions, and its quality[10].

Figure 1. Components of surveillance and response systems for monitoring and evaluation



CD Surveillance and Control Policy Development in Europe

The financial crisis in European welfare systems, especially in the former communist countries, has slowed progress toward targets and reduced the resources available to public health[28].The need for a 'new paradigm' for PHS was clearly stated by WHO in the year 2000:

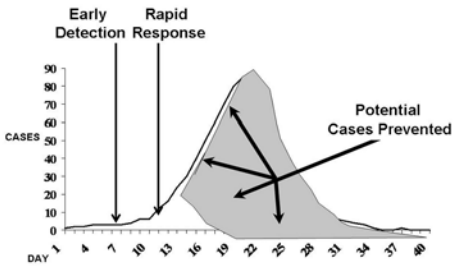
> 'some surveillance systems have lost momentum, are poorly maintained or have virtually collapsed…Outdated surveillance systems, in which new surveillance targets have been added but old ones never removed, often lead to central bodies collecting huge amounts of data with little or no analysis and use of the corresponding information. Feedback to the data collectors is rarely provided. The surveillance system becomes driven by the need to collect and move data while scant attention is given to using the data at each level of the health service for decision-making.'[29]

An essential understanding of surveillance can be promoted through the slogan 'Information for Action'. Figures 2 and 3 illustrate that public health decision making for communicable disease control should result in two types of response[22]:

Figures 2 and 3: Public health response:

Fig 2. Acute (epidemic-type)

Fig 3. Planned (management-type)



Acute responses are analogous to secondary prevention, reducing the overall population impact; whereas planned responses may be aimed at primary prevention of spread and eventual disease elimination. WHO's 2000 paper goes on to describe a surveillance policy solution to the problems of obsolescence, duplication, fragmentation and disconnection from public health action in terms of a strengthened, streamlined system of 'integrated communicable disease surveillance', defined as:

> 'the sum of all surveillance activities which add up to the national surveillance system. The various surveillance activities become integrated into one system within the broader national health information system.'[29]

It is further described as exploiting opportunities for synergy between existing surveillance systems in order to carrying out the core and support functions defined in Figure 1; seeking to maintain surveillance and control functions close to one another organisationally and geographically; and being best approached by developing and strengthening surveillance networks.

In Europe, there are two main drivers of surveillance policy: the International Health Regulations (IHR)[30,31,32] and the body of EC legislation relating to CD surveillance, early warning and response[33]. The IHR specifically request member states to develop and implement national plans of action following an initial assessment of the existing national structures and the resources to implement minimal core capacities for surveillance and response:

Detection at community / primary health level:

(a) to detect events involving disease or death above expected levels for the particular time and place in all areas within the territory;
(b) to report all available essential information immediately; and
(c) to implement preliminary control measures immediately.

Detection at intermediate public health levels:

(a) to confirm the status of reported events and to support or implement additional control measures; and
(b) to assess reported events immediately and, if found urgent, to report all essential information to the national level.

Response at national level:

Assessment and notification.

(a) to assess all reports of urgent events within 48 hours; and
(b) to notify WHO immediately when the assessment indicates the event is notifiable.

Public health response.

(a) to determine rapidly control measures to prevent spread;
(b) to provide support through specialized staff, laboratory analysis of samples and logistical assistance;
(c) to provide on-site assistance as required to supplement local investigations;
(d) to provide a direct operational link with senior health and other officials to approve rapidly and implement containment and control measures;
(e) to provide direct liaison with other relevant government ministries;
(f) to provide, by the most efficient means of communication available for communication of WHO recommendations to the field;
(g) to establish, operate and maintain a national public health emergency response plan, including the creation of multidisciplinary/multisectoral teams to respond to events that may constitute a PHEIC; and
(h) to provide the foregoing on a 24-hour basis.

The IHR were adopted by all 52 member states of WHO's European Region in 2005 and will enter into force at the end of 2007, unless member states specifically opt out. A three phase approach to implementation has been suggested[32], beginning in 2006, providing assistance in assessment 2007-2009, and continuing support and monitoring progress until 2012 The IHR no longer contain prescriptive requirements for international notification of certain diseases but are based on an algorithm requiring the member states to notify a potential Public Health Emergency of International Concern (PHEIC) within 48 hours of its occurrence. A potential PHEIC should be notified when 1) an unusual or severe health-related event has occurred, which 2) may have a significant public health impact, which 3) may spread across borders and 4) may affect free the movement of goods or people. In order to meet these requirements, member states must have an efficient means of confirming or ruling out certain causes of health-related events in order to know whether they meet any of these four criteria. In particular, laboratory services must be adequate for this purpose. It is generally not feasible to maintain laboratories capable of meeting the demands of the IHR under quality assured, or preferably accredited, conditions unless they are integrated into routine health services and CD surveillance. In addition to arguments of economy of scale, maximum return on sunk capital and minimal marginal cost per test, laboratories must maintain proficiency to act in an emergency through routine practice. The same it true for Port Health services. The WHO Regional Office for Europe[34] contains a department for Communicable Disease Surveillance and Response (CSR) with a staff of approximately 10 people and a regular (WHO) budget of $1.4m plus $1.0m from other sources in the biennium 2004-5[35]. However, many other WHO departments contribute to CDS&C and the total number of technical staff in EURO was 310, with a total budget of $155m in 2004/5.

The body of EC legislation[33] relating to CDS&C commenced with a framework decision of the European Parliament and Council (2119/98/EC) establishing Community networks for CDS&C:

> 'As regards epidemiological surveillance, the network shall be established by bringing into permanent communication with one another, through all appropriate technical means, the Commission and those structures and/or authorities which, at the level of each Member State and under the responsibility of that Member State, are competent at national level and are charged with collecting information relating to the epidemiological surveillance of communicable diseases, and by establishing procedures for the dissemination of the relevant surveillance data at Community level.'

The framework has then been elaborated in an ongoing series of Decisions of the European Commission, beginning with 96/2000/EC, which defines ESCON (the Epidemiological Surveillance Component of the Community Network), in terms of a list of diseases for progressive coverage by member states. The scope of this list is necessarily narrower than the IHR, which by implication also cover chemical, radiological and nuclear threats. The operative word 'progressive' means that the EC takes into account members states' current conditions in assessing their progress to harmonization. EWRS (Early Warning and Response System[36]) was established (57/2000/EC) and has similar attributes to WHO GOARN[8]. It defines three phases of activation according to public health risk in a way which is compatible with the IHR algorithm (a useful conceptual overview of early warning and response is available from US CDC[37]). 253/2002/EC sets case definitions for the list of notifiable diseases which was subsequently extended and updated by 534/2003/EC. These case definitions are intended to ensure that the data from member state surveillance systems are 'comparable and compatible'. There are some differences from the case definitions recommended by WHO[38]. The main reason for this is that the EC definitions are intended to achieve comparability and compatibility of national surveillance data by increasing the specificity of diagnoses through laboratory confirmation, whereas the WHO definitions lean more toward sensitivity, in order to estimate burden of disease. The EC case definitions are currently under review by ECDC jointly with the WHO Regional Office for Europe. Given the difference in aim, however, it is not clear that they can be unified into a single system. 542/2003/EC concerns the operation of the Community networks. At the time of writing there are thirteen named disease specific networks plus a basic surveillance network covering all notifiable health conditions on the list[am]. In parallel with the IHR's requirement for member states to produce plans of action, this Decision requires members of the surveillance networks to address a list of topics by submitting Standard Operating Procedures (SOPs) to the Community network, stating:

1. The coordinating structure and decision-making process.
2. Project management administration and supervision.
3. Case definitions, nature, and type of data to be collected.
4. Data management and protection, including data access and confidentiality.
5. Ways in which data are made comparable and compatible (quality requirements and data validation).
6. Appropriate technical means and the procedures by which the data are to be disseminated and analysed at Community level (data dissemination and reporting).
7. Proposed public health action, infection control procedures, and laboratory procedures.

In particular, 542/2003/EC requires the creation of a national point of contact, which could be the same as the IHR 'focal point', and which is in permanent communication with

the European Commission with regard to EWRS. A report of actual notifications to EWRS can be found in 394/2005/COM, and 605/2005/COM gives further guidance in preparing public health emergency plans, covering: information management ; communications ; scientific advice ; liaison and command and control structures; preparedness of the health sector; and preparedness in all other sectors and inter-sectorally. The last major Decision to be published by the end of 2006 (the time of writing), 851/2004/EC, is the founding regulation establishing the European Centre for Disease Prevention and Control (ECDC[39]). It envisages the participation of third countries (who are not member states of the EU) 'which have concluded agreements with the Community by virtue of which they have adopted and apply legislation of equivalent effect to Community legislation in the field covered by this Regulation.' In 2006, ECDC had a budget of €16 million and was set to have 100 staff. The Centre's budget will grow to over €50 million by 2010, and its staff to 300, over the coming years. During the period of its development, the EU Health and Security Committee will continue its responsibilities in relation to IHR at least until 2008 (according to 699/2006/EC), in coordination with the EC, member states and ECDC. The ECDC website contains the membership of its technical Advisory Forum and Managing Board, its work plan, draft framework for an EU surveillance strategy[40], technical programmes and minutes of Managing Board meetings. ECDC is an agency of the European Commission which works in partnership with the national health protection institutes of member states in the areas of: surveillance; scientific advice; identification of emerging health threats ("epidemic intelligence"); training; communications; providing technical assistance ("country support"). Its main activities are:

- Evaluating existing Community networks and reviewing the surveillance objectives for the diseases covered, including:
  (a) providing quality assurance by monitoring and evaluating surveillance activities to ensure optimal operation;
  (b) maintaining the databases for such epidemiological surveillance;
  (c) communicating the results of the analysis of data to the Community network; and
  (d) harmonising and rationalising the operating methodologies.
- Determining the functional specifications of the IT infrastructure.
- Reviewing and updating the case definitions for EU surveillance.
- Integrating laboratory support into surveillance; by:
  (a) encouraging cooperation between expert and reference laboratories, the Centre shall foster the development of sufficient capacity within the Community for the diagnosis, detection, identification and characterisation of infectious agents which may threaten public health.
- Prioritising surveillance needs in collaboration with stakeholders.

In addition to these activities, ECDC is gradually taking over the functions of several ongoing surveillance related projects funded through the EC framework programmes for public health[41], which together with disease specific and basic surveillance networks comprise what is know as the Community network. Eurosurveillance[42] is a peer reviewed, on-line, weekly, monthly and quarterly journal that has archives going back to 1995. It contains outbreak alert notices and investigation reports as well as original articles on epidemiological topics and developments in surveillance methodology. The on-line archive is searchable and it represents the most important single body of professional reflection on surveillance practice within the EU, and presents many practical examples that are relevant to its neighbours. It is available in English and French since 1995, and more recently the quarterly version has been

available in several other Latin languages. Articles from Eurosurveillance are a good source of material for presentation in journal clubs and workshops, because they raise and discuss real world problems and inconsistencies in surveillance.

EPIET[43], the European Programme of Intervention Epidemiology Training, was launched in 1995, based on the lessons learned from field epidemiology training in the Epidemiological Intelligence Service of US CDC[44]. A cohort of ten to twenty field epidemiologists has graduated each year after spending two years as a fellow at one of the accredited training centres in a country other than their own. Most of the EPIET fellows who have been trained so far, approximately 120 in number, have taken up senior posts in European CDS&C, and they are members of the voluntary EPIET Alumni Network (EAN) which provides informal communication between these professionals who speak a common technical language. Younger candidates are selected at competitive interview to give a good representation across EU member states from individuals who intend to pursue a career in field epidemiology, and who have both prior experience and previous epidemiological training, such as a master's degree in public health. The stated mission of EPIET is to:

- Develop a European network of intervention epidemiologists.
- Develop a response capacity inside and beyond the European Union.
- To strengthen communicable disease surveillance and control in the European Union.

EPIET has close links to the European Field Epidemiology Training Programmes (FETPs) in Spain, Italy and Germany that were designed to increase national capacity in field epidemiology. National FETP programmes tend to operate a similar two year fellowship to EPIET but based in their own countries. To be recognised as an FETP, a national training programme must apply for membership of TEPHINET[45], which has over thirty members globally including WHO and US CDC.

IRIDE[46] (Inventory of Resources for Infectious Diseases in Europe) was created in 1997 for fifteen EU member states plus Norway and Switzerland. The project resulted in a computerised database in three languages on CD-ROM, an international workshop, a technical report with an overview of the major collected information translated into 11 languages and printed in 10,500 copies for distribution across Europe. In the year 2000, the web version was created as an updatable European inventory on resources for Infectious Diseases Control, expanding the coverage to accession countries. Results from the inventory are part of the EU-IDA EUPHIN (European Union Public Health Information Network) and HSSCD (Health Surveillance System on Communicable Diseases). ECDC plans further active data collection to refine the inventory and fill in gaps.

Strengthening CD Surveillance and Control and EU Accession Partners

Figure 4 illustrates WHO's recommendations for a planning and management cycle that includes the production of a national plan of action every five years and annual operational plans that coincide with the budgetary cycle of ministries of health.

Although the guidance was not by published until 2006, the main concepts were already well established informally in early 2000's, and they informed the writing of terms of reference for surveillance strengthening projects by ministries in WHO European Region, often through the networks created by the Integrated Capacity Development Programme for Laboratory Specialists run by WHO Lyon Office[47]. The third cohort of this two year programme commenced in 2004 and included Georgia, the Republic of Belarus, the Republic

of Bulgaria, the Republic of Moldova, the Republic of Turkey, Romania, the Russian Federation and Ukraine. This programme focused on strengthening disease detection and response activities in home countries through the elaboration and implementation of a plan of action and specially tailored field training and support.

Figure 4. Cycle illustrating surveillance systems strengthening activities[23]

WHO guidance on systematic assessment of CDS&C systems was published in 2001[48], and a standard questionnaire and methodology for district public health laboratory assessment is available on request from the WHO Lyon Office. A combined team of approximately ten international and national experts is assembled for one to two weeks of desk-top study and field work in a number of locations in the country. Several country assessments are available on WHO websites. TAIEX[49], EC DG SANCO and EC member state national health protection institutes have also collaborated to produce 'peer reviews' of the accession country CDS&C systems, although these reports are confidential. A standardised method is also recommended for achieving consensus in setting national priorities, based on a modified Delphi method[25]. This method requires a national steering committee to produce an overall explanation and specific fact sheets for each of the health-related events for prioritisation, including information on up to eight criteria:1) burden of disease; 2) case fatality rate / severity; 3) epidemic potential; 4) potential threat / changing pattern; 5) health gain opportunity; 6) social and economic impact; 7) international regulations or programmes; 8) public perception. Participants then score each of the criteria for each of the health-related events against a five point ranking scale of importance. Where possible, scale points are given defined meanings in the overall explanation e.g. for burden of disease: 1 is defined as incidence < 1/100,000 per year; 2 is defined as incidence 2 to 10 /100,000 per year, etc. Where clear priorities emerge with a strong consensus, they can be accepted, but where there is a large distribution of scores, a second round of prioritisation may be necessary. Individual's scores are fed back

to them according to their position in the whole distribution of scores, which often prompts them to revise their judgements toward the median.

In addition to the actions of national governments, professional bodies, NGOs and others to strengthen CDS&C, many externally funded projects have been dedicated to this topic. Strengthening complex human and technological systems involving large scale public investment and coordinated action in the private sector, requires a Management and Organisational Development (M&OD) approach. Organisational Development (OD)[50] is understood here to mean a social and behavioural science approach to improving working efficiency, quality of outputs and the quality of life of individuals at work. It is the branch of management science best placed to develop structures, relationships and human resource establishments that optimally discharge surveillance functions within their political and economic settings. It arose simultaneously from the post-WWII 'socio-clinical' studies' at London's Tavistock Institute and the group dynamics 'training laboratories' at the Massachusetts Institute of Technology and other US institutes. Writings on OD tend to stress the importance of the 'psychological contract' between the organisation and its employees, covering areas such as clarity of mission, team working, openness of communication, job security and career pathways. These topics are difficult for externally funded projects to address directly because of the lack of local knowledge and engagement of international consultants, and the location of local consultants in projects 'outside the system'. A fatal but common mistake is to imagine that there was no history before the project began and no relevant future after the project is over. M&OD theory suggests that this mistake can be avoided by considering the project to be a 'temporary parallel learning organisation' of the national system. In other words that the project seeks to engage the thinkers and innovators of the system in an enabling and empowering project environment, giving them the mental space to reflect and plan.

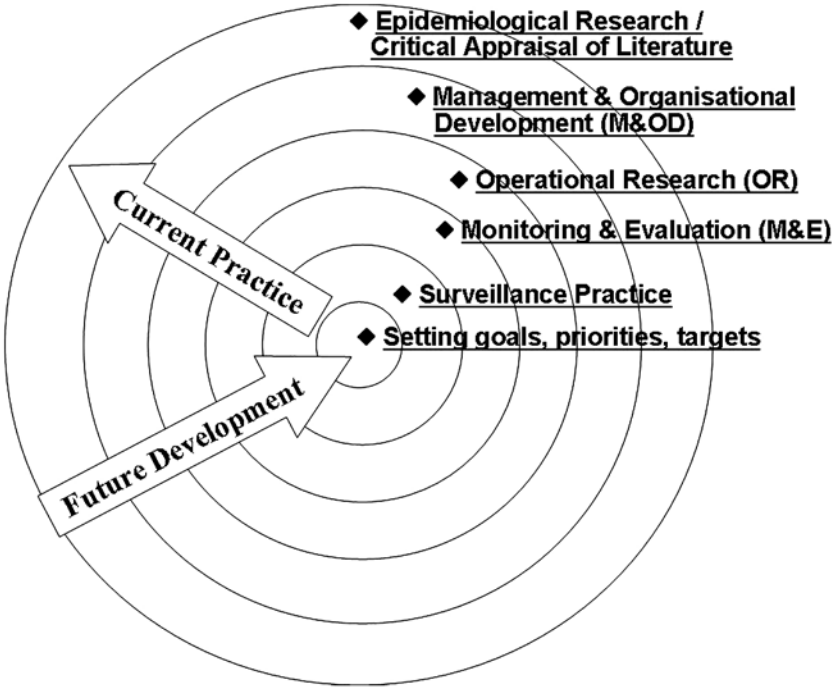
A key M&OD methodology is 'action research', which consists of 1) a preliminary organisational diagnosis 2) data gathering together with working groups of the system 3) data feedback to the working groups 4) exploration of the data by the working groups 5) action planning by the working groups 6) action taking by the working groups 7) evaluation and assessment of the results of actions by the working groups[50]. The project's consultants act as facilitators and technical resources for action research, which differs conceptually from hypothesis-driven research in that it is usually an iterative process of defining and re-defining the research problems, often spiralling into, rather than directly approaching, the solution.

The author was team leader of two substantial EC funded projects on CDS&C strengthening[51,52] which had very similar terms of reference. The Romanian project was preceded by a national conference on public health in the context of EC accession which selected communicable disease surveillance as a topic for which EC funding would be sought. This stimulated a WHO assessment of the system in order to support the preparation of the EC terms of reference. The Romanian project terms of reference were subsequently used as a model for the Turkish project terms of reference, both of which were broad strategies aimed at achieving both institutional reform and large scale capacity building, in implementation periods of only two or three years, respectively. Both projects covered review and harmonisation to EC legislation, guidance and SOPs; human resource development, budgetary assessment and strengthening of administrative arrangements; prioritisation of health-related events for surveillance; development of a new information technology and management system; preparation of a national plan of action; epidemiology training at

basic and post-basic levels (including an EPIET-like three week residential course for 30 people); training in laboratory management, quality assurance and practical public health microbiology; training through applied and operational research; study tours to EC member state institutions; review of biosafety and biosecurity; improvement of biological specimen transportation; technical specifications for supply of laboratory equipment and information technology. The main differences in design were that the Turkish project 1) was intended as an actual transformation of the entire system rather than a pilot implementation, 2) included an assessment of the surveillance and public health laboratory systems, 3) did not include construction work, whereas the Romanian project contained redesign of the national reference laboratory (NRL), 4) included formal training of the trainers in adult education techniques for the delivery of epidemiology and laboratory training cascades down to front-line level, 5) upgraded the biological safety level III capacity of the NTL.

Figure 5 illustrates the increasing levels of sophistication of evidence relevant to decision making in CD strengthening projects. By putting epidemiological research evidence in the outer ring, the diagram is intended to show that the overall territory of CDS&C should be informed by good quality epidemiological studies – those which address the occurrence and determinants of health-related events through hypothesis driven research with adequate statistical power to conclude, and with freedom from serious bias.

Figure 5. Disciplines relevant to strengthening CD surveillance and control



Epidemiology provides the highest level of relevant evidence, and the basic science of all public activity, however epidemiological research generally requires very specific expertise,

considerable financial resources and ethical approval. In developing country settings, it is not generally feasible without external support, and the results of critical appraisal of foreign epidemiological literature should be applied with caution after considering the local context.

Below, and within the domain of epidemiologically justified designs, lies evidence derived from M&OD. There are many differing institutional models of CDS&C in Europe, and to the best of the author's knowledge there are no comparative studies that are methodologically adequate to differentiate the effects of structural design from context. CDS&C tends to evolve from national historically determined health care services, environmental and veterinary practice, vital statistics etc., which in turn reflect specific social and cultural values related to health. Generally applicable M&OD theories related to human resource development and finance, performance management and change management are therefore most relevant conceptual basis for development; and accurate data concerning actual structures, staffing, capital assets and activities are essential.

By operational research (OR), what is meant is 'an investigation carried out, by scientific method, on actual operations, current, recent, or impending, at the request of those responsible for the initiation or conduct of the operations, and explicitly directed to the better, more effective and more economical conduct of similar operations in the future'[53]. It has its own learned societies and journals[54], and is often divided into 'hard' techniques involving mathematical modelling and 'soft' techniques based on social sciences[55]. OR tackles 'messy and complex' problems, often entailing considerable uncertainty, to examine assumptions, facilitate an in-depth understanding and to decide on practical action. It is included in EPIET's description of suitable training activities for fellows[43], may not require ethical approval if it only requires consideration of routine data[56], and its typical applications in surveillance include: assessment of factors affecting timeliness; completeness and accuracy of data; relative performance of diagnostic tests; outbreak 'signal detection' in novel data sets e.g. ambulance dispatch data; developing decision making algorithms; and logistical studies concerning the organisation of laboratory networks and rapid response teams. In terms of the management dictum concerning quality 'Do the right thing, and do the thing right', OR represents an appropriate way of determining the right technical approach to a given problem; whereas M&OD, especially action research, points the way to the best way of implementing it.

The WHO guidance[24] defines monitoring and evaluation as follows:

> 'Monitoring of surveillance systems is the ongoing tracking and analysis of routine measurements aimed at detecting changes in the surveillance system. Evaluation is a process that attempts to determine as systematically and objectively as possible, the relevance, effectiveness, and impact of activities in light of the objectives. Several evaluations can be distinguished, e.g. evaluation of structure, process, output, outcome and impact. Impact is the extent to which the overall goal of the surveillance and response systems is being achieved, e.g. reduction in the case-fatality rate of epidemic-prone diseases, changes in the morbidity pattern of targeted communicable diseases or changes in behaviours of health staff and of the general population'[24].

The guidance contains 95 suggested indicators covering the four domains of Figure 1 to aid the monitoring of progress towards established targets. The list is intended to be adapted

to country settings and, if necessary, additional indicators to monitor implementation of the national plans of action should be identified. Indicators should be pre-tested for usefulness, clarity, availability of denominator and numerator data, ease of collection and calculation of measurements. The planning and development activity alone that is required to introduce and test such a broad range of new indicators is a considerable task. Furthermore, over half of the indicators relate to infrastructure and training that would require a major investment programme in order for the 'poorly maintained' and 'virtually collapsed' systems to catch up with the EU average. Where an investment programme is contemplated, restructuring of the surveillance system should move away from the vertical systems of formal notification to integrated systems which build capacity for surveillance at lower levels, close to where control activities take place. Figures 6 and 7 are intended to illustrate the necessary integration of systems.

Figures 6 and 7: Restructuring Surveillance Systems:

Fig 6. Vertical Notification System

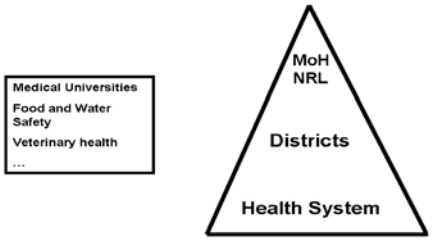
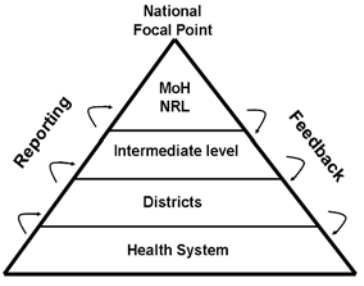


Fig 7. Horizontally Integrated Intelligence System



All national CDS&C systems need to be hierarchically organised in order to operate the clear lines of command necessary to respond to a national emergency and to cover the entire territory with qualified field epidemiological input. However, the pyramid needs to be broad enough so that intelligence can flow through personal networks operating at all levels. A major goal of training activities should be to establish these networks though through case studies and simulation exercises. Routine management cycles between levels, i.e. reporting of data to the level above and feedback of interpreted action-reports to the level below, make data consistency checking, validation and quality assurance feasible. It is not practically possible for staff in distant ministries of health to change the data collecting behaviour of individual laboratories and clinicians. Providing sub-national staff are well trained, experienced and committed to quality, their local knowledge can be harnessed to develop a national health intelligence system that may not require great investments in information technology. The software component of a national electronic surveillance system was established in Germany for just €170,000 initial development cost plus €150,000 per year for maintenance and ongoing improvement[57]. Another crucial issue that Figure 7 is supposed to illustrate, however, is that a broadening of the base of the pyramid requires also a broadening of the mid-sections and the top. Staff with the ability and training to run epidemiological intelligence systems cannot be created overnight. Again, Germany provides a cost-effective model for training high quality professionals through a national FETP[58]

Prospects and problems in CDS&C

The greatest problem for the weaker CDS&C systems in WHO's European Region is the scale of investments and activities required to meet the legally required international standards. Despite the potentially disastrous consequences of mishandling a major epidemic, in terms of human suffering, damage to trade and political repercussions, both the absolute and relative amounts of domestic funding directed to public health systems are far too low. Donor funded projects can act as a catalyst for change, and can provide targeted investments, but medium to long term national capital development programmes are required to institutionalise change and to create sustainable development. In countries where the public health laboratory infrastructure has been allowed to deteriorate, the costs of re-establishing a modern dedicated network can be high. Where there are good quality laboratories in state and university hospitals, it is tempting to utilise some of this capacity by contractual agreement with the ministry of health. There are few national examples, however, where ministries of health have been prepared to rely solely on the capacity of clinical laboratories. A good compromise may be to maintain a national reference laboratory for policy development, training, specialised testing, quality assurance and consultancy, with a small sub-national network of public health laboratories that each coordinate the public health activities of hospital / university clinical laboratories in their region, and provide confirmatory testing.

Perhaps the second greatest problem for weaker CDS&C systems relates to the organisation of trained medical and technical labour. Where real salaries and benefits are much lower in public health than clinical practice, and where the private sector offers more attractive remuneration, recruiting, training and retaining professional staff can be problematic. Like the need for capital investment referred to above, the only solution to this problem is a properly resourced policy commitment. The scope for development within existing institutions is often very limited because overall health sector strategies and restructuring plans prohibit the creation of new posts or departments, and public sector employment law may establish mandatory pay norms and protect staff positions, even though they are no longer required. Primary legislation may be necessary to create new institutions and, in any case, there is often more scope for developing non-financial incentives, including: high levels of training professional, academic interest and professional recognition; a well described progressive career pathway; joint academic posts; and opportunities for international representation.

Overall, however, the prospects look good for strengthening of CDS&C in Europe. Greater awareness of the potentially disastrous consequences of emerging and re-emerging diseases and bio-terrorism has resulted in a steep increase in the availability of international development funding. ECDC, and the ongoing development programmes that it has inherited, look set to improve the standardisation of national systems across the EU, which will also positively influence its neighbours. Technical advances are rapidly making CDS&C not only more effective, but also more professionally interesting. Automation of data collection and processing frees professional staff to interrogate databases and to interpret information rather than simply preparing tables of data. Improvements in nucleic acid test diagnosis and genetic typing of micro organisms are bringing CD epidemiology closer to its basis in population biology, and with the aid of insights from mathematical modelling, it is becoming possible to ground policy on a more scientific evidence base.

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