



**Finding value in the evaluation of public health syndromic surveillance systems from a policy perspective.**

**Author: Saqib Shahab, SEARCH Cohort VI**

**SEARCH Faculty Advisor: Dr Duncan Saunders.**

**AHS Supervisors: Dr James Talbot, Vanessa Nardelli, Dr Gerry Predy**

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**Contact Information:**

Dr Saqib Shahab, Community Medicine Program, University of Alberta.

#300, 10216- 124<sup>th</sup> Street, Edmonton, Alberta, T5N 4A3.

Tel: 780 413 4924.

Fax: 780 413 7950.

e mail: sshahab@ualberta.ca

## **Abstract.**

### **Finding value in the evaluation of public health syndromic surveillance systems from a policy perspective.**

#### **Background:**

This project aimed to identify and assess published approaches to evaluation of surveillance systems. Investment and interest in surveillance systems has increased after the events of 9/11 in 2001, SARS in 2003, proclamation of the World Health Organization International Health Regulations in 2005, concerns about Avian Influenza, and more recently in 2009 the evolving potential pandemic due to a Swine origin Influenza H1N1 strain.

Investments have not only been made in traditional public health surveillance systems but also novel approaches such as syndromic surveillance systems. It is important to have timely, relevant evaluations of these systems to assess their usefulness at both the operational level in terms of technical accuracy and feasibility as well as at the organizational level in terms of cost effectiveness, risk management, and adherence to standards and best practices.

#### **Literature identification and selection:**

Pubmed search terms were developed and searches in Pub Med conducted. Google was used to search grey literature. Wikis dealing with surveillance were subscribed to and explored. Text books on surveillance were consulted. Citations of key articles were perused to further ensure saturation of the published literature.

#### **Comparison of evaluation frameworks:**

Three frameworks were selected for a more detailed comparison. They were selected because of having been cited most frequently (CDC), of global significance (WHO), and specific to the Canadian context (PHAC). Thematic elements of the three frameworks were tabulated and compared and contrasted.

#### **Findings:**

1. There is increasing use of specific frameworks to guide evaluation of surveillance systems.
2. The framework developed by the US Centers for Disease Control (CDC) is the most commonly cited framework in recent published literature.
3. Public Health Agency of Canada (PHAC) has developed its own framework for evaluation. The Auditor General of Canada has recommended that this framework be used to guide evaluation of PHAC surveillance systems.
4. The three frameworks relevant for the Canadian context (CDC, PHAC, WHO) are showing increasing convergence in systematically evaluating not just technical attributes of the system but also system attributes such as acceptability, usefulness, simplicity, portability, stability and cost.

**Relevance and recommendations**

1. Adoption of a standardized evaluation framework would encourage comprehensiveness and comparability.
2. The stage at which evaluations are done should guide evaluation purpose and design. Initial exploratory evaluations are essential to identify needs, resources, capacity and sustainability. Intermediate process and formative evaluations could highlight issues with system operationalization. Summative and ongoing evaluations evaluate impact and outcomes as well as monitoring ongoing system usefulness and relevance.

**Key points for policy makers:**

From a policy perspective, standard frameworks are available to conduct comprehensive, context specific yet comparable evaluations of public health surveillance systems.

Aspects of an evaluation of a surveillance system that are important at a policy level include factors that evaluate whether the system:

1. Meets or exceeds best practice / standard
2. Is cost effective
3. Manages risk
4. Enhances organizations integration and efficiency
5. Is flexible- adapts to changing needs and environments

**Question:**

Finding value in the evaluation of public health syndromic surveillance systems from a policy perspective.

**Context:**

This project aimed to explore whether surveillance systems are evaluated, how are those evaluations conducted, and what value do those evaluations bring to the use of surveillance systems in public health.

Evaluation has gained increasing acceptance over the past few decades as a technical discipline. There are increasing expectations that pilot projects as well as ongoing programs should have an evaluation component. Numerous methodologies for evaluation employing a variety of management and research approaches have been developed.

Within public health, surveillance systems have been used extensively at global, national, provincial and local levels. Investment in surveillance systems has been accelerated after the events of 9/11 in 2001, SARS in 2003, proclamation of the World Health Organization International Health Regulations in 2005, concerns about Avian Influenza, and more recently in 2009 the evolving potential pandemic due to a Swine origin Influenza H1N1 strain.

Investments have not only been made in traditional public health surveillance systems but also novel approaches such as syndromic surveillance systems.

It is important to have timely, relevant evaluations of these systems to assess their usefulness at both the operational level in terms of technical accuracy and feasibility as well as at the organizational level in terms of cost effectiveness, risk management, and adherence to standards and best practices.

**Literature identification and selection:**

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A glossary (Table 4) was started to define commonly used terms. A bibliographic table was developed listing references selected for citation as well as summarizing their key themes and commenting on their relevance to this project (Table 5).

**Table 1: Literature search strategy:**

<b>Objective</b>	<b>Approach</b>	<b>Results</b>	<b>Comments</b>
Develop familiarity with the field	Google, using “Surveillance evaluation”	Useful environmental scan identified CDC, PHAC and WHO as key sources.	Adding “framework” to the search fields gave more appropriate results
Collect representative articles	Pub med search using “evaluation surveillance framework”	Terms too broad. Adding “syndromic” yielded 9 articles.	5 articles considered suitable for further review
Read around key articles	“Related articles” functionality of 5 selected articles used	Key articles appearing repeatedly selected	I personally found this Pub med function very useful although the program and not the individual is in control
Check for key cross references	Citations of reference review articles reviewed	CDC and WHO frameworks often cited in evaluations of surveillance systems published in peer reviewed journals	Having a framework in the peer reviewed publication domain increases its credibility, utilization at least by evaluators intending to publish, and impact in terms of citations.
To assess utilization of selected evaluation frameworks in the published literature	Number of times key reference articles cited in Scopus determined	Useful to see successive iterations of CDC framework continues to be widely cited.	“Number of times cited” useful functionality of some online literature search databases.
Grey literature searched for Canadian context	Google, with Canadian sources only off and on.	PHAC Framework and Auditor Generals report retrieved	Key Canada specific evaluation framework would have been excluded if search had been limited to Pub Med
Manual scan of key articles to look at references to generic surveillance system evaluation frameworks	In addition to CDC, WHO (1997) framework also frequently mentioned	WHO framework mentioned in the references but does not appear indexed cross references as frequently as the CDC reference; maybe because it is	WHO framework appears to be a key framework for data definitions and terminology. CDC does a good job of ensuring even its institutional

Objective	Approach	Results	Comments
		an institutional publication and not a “peer reviewed publication”.	publications that appear in MMWR are peer reviewed and hence included in Pub Med. PHAC and WHO may get greater exposure and credit for their work if they follow this approach.

**Data extraction and summary:**

**Environmental scan of frameworks appropriate for evaluating surveillance systems:** Three frameworks were considered appropriate in the Canadian context. They are the CDC, WHO and the PHAC framework. A comparison of thematic elements of the three frameworks was done (Table 2).

**Table 2: Thematic elements of three selected frameworks:**

<b>Framework ►</b>	<b>WHO</b>	<b>CDC</b>	<b>PHAC</b>
<i>Common / unique theme ▼</i>			
<i>Sponsoring organization</i>	<b>World Health Organization</b>	<b>Centers for Disease Control USA</b>	<b>Public Health Agency of Canada</b>
<i>Title</i>	Protocol for the Evaluation of Epidemiological Surveillance Systems 1997	Framework for Evaluating Public Health Surveillance Systems for Early Detection of Outbreaks 2004	Framework and Tools for Evaluating Health Surveillance Systems 2004
<i>System Description / context</i>	Population under surveillance	A. System description:	Step 1- Establishing the Context
<i>Objectives / purpose of the system</i>	Objectives of the system	1. Purpose	Purpose
<i>Stakeholders / roles and responsibilities</i>	Resources available to the surveillance system	2. Stakeholders	Roles and Responsibilities
<i>System design and scope</i>	Flow diagram of the surveillance system	3. Operation	Design and Scope
<i>Evaluation / logic models</i>			Risks and Issues: Logic Model: Objectives, Outputs, Outcomes, Impacts
<i>Outbreak detection</i>	Detection of events	B. Outbreak detection	

<b>Framework ►</b>  <i>Common / unique theme ▼</i>	<b>WHO</b>	<b>CDC</b>	<b>PHAC</b>
<i>Evaluation / indicators</i>	Events under surveillance	1. Timeliness: <ul style="list-style-type: none"> <li>a. Onset of exposure</li> <li>b. Onset of symptoms</li> <li>c. Onset of behavior</li> <li>d. Capture of data</li> <li>e. Completion of data processing</li> <li>f. Capture of data in public health surveillance system</li> <li>g. Application of pattern recognition tools / algorithms</li> <li>h. Generation of automated alert</li> <li>i. Initiation of public health investigation</li> <li>j. Initiation of public health intervention</li> </ul>	Step 2- Identifying Evaluation Questions (SMART)

<b>Framework ►</b>  <i>Common / unique theme ▼</i>	<b>WHO</b>	<b>CDC</b>	<b>PHAC</b>
<i>Data validation and representativeness</i>		2. Validity: <ul style="list-style-type: none"> <li>a. Case definitions</li> <li>b. Baseline estimation</li> <li>c. Reporting delays</li> <li>d. Data characteristics</li> <li>e. Outbreak characteristics</li> <li>f. Statistical analysis</li> <li>g. Epidemiologic analysis, interpretation and investigation</li> </ul> Validation approaches Statistical Assessment of Validity Data Quality: <ul style="list-style-type: none"> <li>• Representativeness</li> <li>• Completeness of Data</li> </ul>	

<b>Framework ►</b>  <i>Common / unique theme ▼</i>	<b>WHO</b>	<b>CDC</b>	<b>PHAC</b>
<i>Specific system attributes</i>		C System experience 1. System usefulness 2. Flexibility 3. System acceptability 4. Portability 5. System stability 6. System costs	Surveillance system characteristics: <ul style="list-style-type: none"> <li>• Acceptability</li> <li>• Simplicity</li> <li>• Flexibility</li> <li>• Data Quality</li> <li>• Positive Predictive Value</li> <li>• Sensitivity</li> <li>• Representativeness</li> <li>• Timeliness</li> <li>• Stability</li> <li>• Compliance</li> </ul> System performance characteristics <ul style="list-style-type: none"> <li>• Effectiveness</li> <li>• Efficiency</li> </ul> Usefulness
<i>Reporting and decision making- “Information for Action”</i>	Reporting procedures Decision making and action taken		Step 3- data Collection / Management

<b>Framework ►</b>  <i>Common / unique theme ▼</i>	<b>WHO</b>	<b>CDC</b>	<b>PHAC</b>
<i>Findings and feedback for improvement</i>	Feedback	D Conclusions and recommendations for Use and Improvement of Systems for Early Outbreak Detection	Findings

### **Thematic analysis and comparison of the three frameworks:**

- A. Developing the context: All three frameworks require a system description
- B. Objectives and purpose: specified uniformly in all three frameworks.
- C. Identifying partners and stakeholders: PHAC makes this most explicit, especially in terms of roles and responsibilities. CDC identifies stakeholders. However, non surveillance specific texts on evaluation by CDC and others go to great lengths to articulate stakeholders and the importance of their involvement in evaluation processes.
- D. Specific characteristics of the surveillance system: All three frameworks list specific technical characteristics that should be described concerning surveillance systems. There is some overlap of these technical issues.
- E. All three frameworks require descriptions of the system.
- F. All three frameworks recommend measuring technical aspects of the system using traditional quantitative epidemiological indicators.
- G. There is greater emphasis in all three frameworks, and their repeat iterations, on system experience. This includes an evaluation of attributes such as usefulness, flexibility, acceptability, portability, stability and costs.

### **Further discussion on evolution of evaluation frameworks for surveillance systems:**

#### **The following have been noted in the literature:**

- H. Linear vs. iterative process: Over the years, in the three frameworks and elsewhere, there seems to be a process of change from a linear process to an iterative one.
- I. Intrinsic and extrinsic value of surveillance systems:
  - a. Intrinsic value is primarily to the team who designs and builds a system, and is the primary analyzer and user of the data.
  - b. Extrinsic value may be internal to the organization; for example groups that create the data; senior executives; as well as external to the organization; for example funding bodies; communities and the public; other regions and jurisdictions; and academia.
- J. Focusing the evaluation: It is challenging and possibly not always necessary to design and conduct an evaluation that addresses all program aspects and components. Actual evaluations varied in terms of how explicit they were in terms of who the specific audience for the evaluation was and how it was intended to be used.
- K. Publication bias: Most of the published evaluations looked at technical attributes of the system i.e. accuracy. Other aspects such as utility, feasibility and propriety as given in the generic CDC evaluation framework (CDC 1999) were not always explicitly addressed.

### **Findings and analysis:**

- 1. There is increasing use of a framework to guide evaluation of surveillance systems.

2. The World Health Organization has published a protocol for evaluation of surveillance systems that is simple, straightforward and applicable in resource poor settings (WHO 1997). It has useful sections related to definitions and standards.
3. The framework developed by the US Centers for Disease Control (CDC 2004) is the most commonly cited framework in recent published literature. This framework is an update of guidelines first published in 1988 (CDC 1988) and updated in 2001 (CDC 2001).
4. Public Health Agency of Canada (PHAC 2004) has developed its own framework for evaluation. The Auditor General of Canada has recommended that this framework be used to guide evaluation of PHAC surveillance systems (OAG 2008).
5. The three frameworks relevant for the Canadian context (CDC, PHAC, WHO) are showing increasing convergence in systematically evaluating not just technical attributes of the system but also system attributes such as acceptability, usefulness, simplicity, portability, stability and cost.

## **Relevance and recommendations**

**1. Adoption of a standardized evaluation framework would encourage comprehensiveness and comparability.** Several evaluations of surveillance systems in the literature used evaluation methods that are more generic to evaluation per se and not necessarily specific to evaluation systems. So while the evaluations may be very context specific, it was difficult to use them to compare and contrast even similar surveillance systems.

**2. Initial exploratory, intermediate formative and process, and final impact and outcome evaluations serve different purposes.** Initial evaluations are essential to identify needs, resources, capacity and sustainability. This may be an appropriate time to develop a logic model of a proposed surveillance system, listing inputs, processes, outputs and short and long term outcomes. Intermediate evaluations could highlight issues with system operationalization. These can also be formative evaluations that may be required as a condition by funding bodies for new or pilot projects. Final and ongoing evaluations evaluate impact of outcomes as well as monitoring ongoing system usefulness and relevance. Final evaluations are often conducted when a pilot project ends and a report to the funding body is required. It appears from the grey literature that many pilot projects do not go on to be an ongoing program. This could result from a lack of consideration of long term feasibility and sustainability at the time of project commissioning. Similarly, there was very little information regarding ongoing evaluation of established surveillance systems. This may be important to ensure that surveillance systems remain relevant, cost effective and continue to meet changing organizational and population needs.

Based on the literature review, an iterative approach was used for evaluation of an actual surveillance system, the Alberta Real Time Syndromic Surveillance System (ARTSSN) (Table3).

**Table 3: Development of an evaluation plan based on local project literature review:**

<b>Project phase</b>	<b>Evaluation component</b>	<b>Approach</b>	<b>Outcome</b>	<b>Comments</b>
Concept case	Needs assessment	Review of concept papers / proposals	Proof of concept approved by management committee	Initial case was well thought out and presented to key managers
Business case	Needs assessment	Review of Advisory, Management and Core Committee minutes	Business case identified start up funding from AHW, contributions of AHS-CHS, and projected impacts and benefits.	Business case was pragmatic given the initial resources.
Commissioning of initial test phase	Formative	Review of project updates	Regular project updates were maintained and reviewed regularly by core committee members. Concise pertinent summaries were shared with Management Committee	A high priority was placed on keeping key managers apprised of project progress and deliverables.
Initial go live stage	Formative. Summative for pilot.	Feedback from survey	Generally positive feedback to project stage and communication	Survey conducted through survey monkey
Further enhancements	Needs assessment	Advisory and core committee meetings. Review of logic model	Recommendations made regarding how quickly ARTSSN should expand, who future potential partners could be, and how could the role and utilization of ARTSSN be enhanced.	Logic model developed by the core committee good visual aid to map progress and future direction. Advisory committee brought national and international experts in surveillance together with ARTSSN team members to further articulate current achievements and future potential, risks and plans.

<b>Project phase</b>	<b>Evaluation component</b>	<b>Approach</b>	<b>Outcome</b>	<b>Comments</b>
Integration into routine business practice	Formative. Summative for pilot.	Feedback from repeat survey.	Survey currently in progress.	Ongoing feedback from systems users, managers, funders and other stakeholders considered essential to ensure long term sustainability and relevance of the surveillance system.
Impact and outcome evaluation	Summative	Epidemiological and expert approaches to assess impact of ARTSSN in outbreak and trend detection.	Process continues, with presentations at conferences, and to internal and external stakeholders.	Should assess role of ARTSSN in detecting and prompting action on indicators of significance. An evaluation of benefits / economic impact to the organization and population would be a useful consideration in the future.

**Key points for policy makers:**

From a policy perspective, standard frameworks are available to conduct comprehensive, context specific yet comparable evaluations of public health surveillance systems.

Aspects of an evaluation of a surveillance system that are important at a policy level include factors that evaluate whether the system:

- Meets or exceeds best practice / standard
- Is cost effective
- Manages risk
- Enhances organizations integration and efficiency
- Is flexible- adapts to changing needs and environments

It is important that decision makers are aware of these issues when commissioning new surveillance systems or considering changes or enhancements to existing surveillance systems.

**Personal lessons learnt from the local project:**

1. Evaluation is not a one off process but an iterative process that is embedded in the life cycle of program planning and development.
2. Evaluation is done “by” programs and not “on” programs.
3. Ultimately, publication in credible peer reviewed literature is essential to add to the body of knowledge.
4. Frameworks designed specifically for evaluation of surveillance systems help to “anchor” an evaluation to ensure that key areas are considered. However, depending on project stage, scope and audience, not all areas may be addressed concurrently or prospectively.
5. The focus of evaluations are very target audience specific. In the published literature, the focus seems to be more on technical attributes, which may not be the only / most important priorities for policy makers.

**Table 4: Glossary**

<b>Term</b>	<b>Definition</b>	<b>Source</b>
<b>Evaluation</b>	Acts related to measurement or exploration of a systems properties	Pp3 Evaluation methods for health informatics Brender 2006
<b>Health informatics</b>	Science that underlies the academic investigation and practical application of computing and communications technology to healthcare, health education and biomedical research.	<a href="http://www.healthsystem.virginia.edu/Internet/phs/informatics/HealthInfDef.cfm">http://www.healthsystem.virginia.edu/Internet/phs/informatics/HealthInfDef.cfm</a>
<b>Health informatics, public health</b>	Public Health Informatics has been defined as the systematic application of information and computer science and technology to public health practice, research, and learning. It is one of the sub domains of (bio)medical or health informatics. In the same way that Public Health as a distinct field relates to healthcare generally, public health informatics is distinguished from healthcare informatics by emphasizing data about populations rather than that of individuals. The activities of public health informatics can be broadly divided into the collection, storage, and analysis of data of interest to the various activities of public health.	<a href="http://en.wikipedia.org/wiki/Public_health_informatics">http://en.wikipedia.org/wiki/Public_health_informatics</a>
<b>Surveillance, public health</b>	Public health surveillance is the systematic, ongoing assessment of the health of a community, based on the collection, interpretation, and use of health data. Surveillance provides information necessary for public health decision making.	Principles and Practice of Public Health Surveillance, Ed Teutsch S, 2 <sup>nd</sup> Ed
<b>Syndromic surveillance</b>	The collection and analysis of pre-diagnosis information that lead to an estimation of the health status of the community	DOD-GEIS. <a href="http://ndms.umbc.edu/conference2003">http://ndms.umbc.edu/conference2003</a> /Proceedings/conf12_Biosurveillance_Lobardo.pdf

<b>Term</b>	<b>Definition</b>	<b>Source</b>
<b>Syndromic surveillance</b>	An investigational approach where health department staff, assisted by automated data acquisition and generation of statistical alarms, monitor disease indicators in real-time or near real-time to detect outbreaks of diseases earlier than would otherwise be possible with traditional public health methods.	CDC. Draft Framework for Evaluating Surveillance Systems for Early Detection of Outbreaks. August 26, 2003.
<b>System</b>	All the components, attributes, and relationships needed to accomplish an objective	Pp3 Evaluation methods for health informatics Brender 2006

**Table 5: Bibliography with identification of key themes and comments.**

Reference	Theme and comments
Ammenwerth E, Gräber S, Herrmann G, Bürkle T, König J.(2003) Evaluation of health information systems-problems and challenges. Int J Med Inform. 2003 Sep;71(2-3):125-35.	Good classification of main problem areas in evaluation of surveillance systems
Bingle, C. L Holowaty P, Koren I, Picard L et al. An evaluation of the Ontario Rapid Risk Factor Surveillance System Canadian Journal of Public Health, 2005 (Vol. 96) (No. 2) 145-150	Evaluation Framework Application: good example of interim formative evaluation using CDC and WHO frameworks. Good use of a context specific logic model to guide evaluation.
Brender J. Handbook of evaluation methods for health informatics. 2006 Elsevier.	Short summaries of evaluation methods for health informatics
Buckeridge DL 2007. Outbreak detection through automated surveillance: a review of the determinants of detection.J Biomed Inform. 2007 Aug;40(4):370-9.	Frequently cited review of technical aspects of automated outbreak surveillance systems. Comprehensive list of references in the end.
CDC (1988) Guidelines for evaluating surveillance systems. (1988) MMWR. Morbidity and mortality weekly report, 37 Suppl 5, pp. 1-18.	Earliest iteration. Cited in Scopus 131 times.
CDC (1999) Framework for Program Evaluation in Public Health. MMWR. September 17, 1999 / 48(RR11);1-40 <a href="http://www.cdc.gov/mmwr/preview/mmwrhtml/rr4811a1.htm">http://www.cdc.gov/mmwr/preview/mmwrhtml/rr4811a1.htm</a>	Generic and widely used framework for evaluation of public health programs; not specific to evaluation of surveillance systems.
CDC (2001) Updated guidelines for evaluating public health surveillance systems. MMWR Morb Mortal Wkly Rep. 2001;50:1-35.	Evaluation Framework Development: Key evaluation framework, widely cited.
CDC (2004) Framework for Evaluating Public Health Surveillance Systems for Early Detection of Outbreaks. MMWR. May 7, 2004 / 53(RR05);1-11 <a href="http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5305a1.htm">http://www.cdc.gov/mmwr/preview/mmwrhtml/rr5305a1.htm</a>	Evaluation Framework Development: Key evaluation framework, widely cited. (45 citations on Scopus)
CDC Annotated Bibliography for Syndromic Surveillance: <a href="http://www.cdc.gov/epo/dphsi/syndromic/index.htm">http://www.cdc.gov/epo/dphsi/syndromic/index.htm</a>	Good collection on recent publications specifically on syndromic surveillance systems.
Doroshenko A,Cooper D,Smith G, Gerard E et al. (2005) Evaluation of Syndromic Surveillance Based on National Health Service Direct Derived Data -England and Wales. MMWR August 26, 2005 / 54(Suppl);117-122	Utilization and validation of CDC framework in evaluating a national level surveillance system

Reference	Theme and comments
Eurosurveillance (2008) Online journal. <a href="http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=626">http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=626</a>	Useful references at the end
ISDS (2008) International Society for Disease Surveillance. Online resource. <a href="http://www.syndromic.org">http://www.syndromic.org</a>	Useful site with Wiki
OAG – Office of the Auditor General of Canada (2008) Report of the Auditor General of Canada Chapter 5—Surveillance of Infectious Diseases—Public Health Agency of Canada <a href="http://www.oag-bvg.gc.ca/internet/English/aud_ch_oag_200805_05_e_30701.html">http://www.oag-bvg.gc.ca/internet/English/aud_ch_oag_200805_05_e_30701.html</a>	Observations and recommendations on surveillance: need for regular needs assessment and evaluation
PHAC (2004) Framework and Tools for Evaluating Health Surveillance Systems. PHAC. <a href="http://www.phac-aspc.gc.ca/php-ppsp/hssef_e.html">http://www.phac-aspc.gc.ca/php-ppsp/hssef_e.html</a>	Auditor General in May 2008 report recommends this framework be updated and used. PHAC has agreed to that.
Rahimi B, Vimarlund V. (2007) Methods to evaluate health information systems in healthcare settings: a literature review. J Med Syst. 2007 Oct;31(5):397-432.	Comments on lack of standardization in evaluation
Rolfhamre P, Janson A, Arneborn M, Ekdahl K. (2006) Description of an internet-based surveillance system for communicable dis Euro Surveill. 2006;11(5):pii=626. <a href="http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=626">http://www.eurosurveillance.org/ViewArticle.aspx?ArticleId=626</a>	Evaluation of a surveillance system; good overview of timeliness, accessibility of data, completeness, and comparison with other national surveillance systems (notably Netherlands, Ireland, Germany and the US RODS system)
Teutsch SM. (2000) Considerations in planning a surveillance system. In: Teutsch SM, Churchill RE (eds). Principles and practice of public health surveillance. New York: Oxford University Press, 2000:17–29.	Surveillance: Standard text. Widely cited.
Watkins R, Eagleson S, Hall R, Dailey L et al. (2006). Approaches to the evaluation of outbreak detection methods. BMC Public Health, 6:263 doi:10.1186/1471-2458-6-263	Good recent review of approaches towards evaluation of surveillance systems. Conceptualizes evaluation into four main domains of "Descriptive", "Derived", "Epidemiological" and "Simulation".
WHO (1997) Protocol for the Evaluation of Epidemiological Surveillance Systems. WHO/EMC/DIS/97.2. 1997. Available from: <a href="http://whqlibdoc.who.int/hq/1997/WHO EMC DIS 97.2.pdf">http://whqlibdoc.who.int/hq/1997/WHO EMC DIS 97.2.pdf</a>	Evaluation Framework Development: Key evaluation framework, widely cited, especially in earlier literature (prior to 2000).

Reference	Theme and comments
WHO (2005) Evaluating the costs and benefits of national surveillance and response systems. <a href="http://www.who.int/csr/resources/publications/surveillance/WHO_CDS_EPR_LYO_2005_25/en/index.html">http://www.who.int/csr/resources/publications/surveillance/WHO_CDS_EPR_LYO_2005_25/en/index.html</a>	Addresses evaluation from an economic cost benefit perspective. Has useful formulae and templates that can be applied. Stresses evaluation of economic impacts of surveillance systems and not just attributes, structure and function.
WHO (2005) International Health Regulations. World Health Organization <a href="http://www.who.int/csr/ihr/capacity/en/index.html">http://www.who.int/csr/ihr/capacity/en/index.html</a>	Specific and new diseases and outbreaks of concern require reporting to WHO within 24 hours- near real time; to be fully implemented by member states by 2012
WHO (2006) Communicable disease surveillance and response, guide to monitoring and evaluating. World Health Organization <a href="http://www.who.int/csr/ihr/rescentreJune2007/en/index14.html">http://www.who.int/csr/ihr/rescentreJune2007/en/index14.html</a>	Update of the 1997 framework with useful tools for calculating technical system attributes