

Screening in Public Health and Clinical Care: Similarities and Differences in Definitions, Types, and Aims – A Systematic Review

MARK SPEECHLEY¹, ABRAHAM KUNNILATHU², EBY ALUCKAL³, M S BALAKRISHNA⁴, BENYO MATHEW⁵, ELDHOSE K GEORGE⁶

ABSTRACT

Introduction: The concept of screening can be many times misleading to many people. This may be partly due to the way screening is described and explained in textbooks and journal articles.

Aim: To review prominent public health and epidemiology textbooks, dictionaries, and relevant journal publications for definitions and examples of screening, with the aim of identifying common usages and concepts, as well as sources of potential confusion.

Materials and Methods: Commonly available epidemiology and public health textbooks and peer reviewed journals were searched for definitions and examples of screening. The search located seven journal articles, 10 textbooks, and one dictionary. The search platforms used were Pubmed, BIOSIS, EMBASE, Medline-OVID and Scopus under the Epidemiology and Biostatistics subject head listed with Life Sciences.

Results: Descriptions of screening give varying emphasis to whether it is a test or a program, the aims of screening, the setting in which it is conducted, eligibility criteria, who initiates and who is intended to benefit and whether the condition being screened is an infectious or chronic disease or a risk-elevated state. Four essentially different ‘types’ of screening are described, using seven terms and occasionally contradictory examples. The detection of asymptomatic infectious cases is gradually changing from screening to surveillance as part of infection control.

Conclusion: Voluntary screening programs rely on high participation to be effective and support and trust of the public are essential for the continued success of the public health profession. Consistent terminology is important for patients, providers and policymakers to understand what screening is and is not. Clear definitions are needed if we are to evaluate and communicate the risks and benefits of screening in public health.

Keywords: Clinical practice, Public health screening programs, Surveillance

INTRODUCTION

Screening is a fundamental concept that links clinical practice in individuals, with public health practice in populations. It is a very popular publication subject: a 2016 search of PubMed for ‘screening program’ by the authors retrieved over 120,000 references; a search for ‘screening test’ returned over 590,000 hits. When textbooks are included, current usage of ‘screening’ now spans the detection of entities across the entire bio-psycho-social continuum, and from the primordial to the quaternary levels of prevention. Verbs and nouns mingle freely: people called ‘screeners’, using things called ‘screeners’, ‘screening tests’, or ‘screens’, look for gene mutations, the presence of antibodies or extreme physiological values, they might validate diagnostic and prognostic indicators, they may seek to uncover unhealthy domestic environments, or they might replace long versions of questionnaires with shorter ones. Authors list several different definitions and examples of ‘types’ of screening.

The problem of terminological confusion was noted over 40 years ago [1]. Our present understanding is further impeded because distinct public health concepts such as ‘surveillance’ are defined as a type of screening in some clinical texts [2]. Twenty years ago, Nicholas Wald, founding editor of the *Journal of Medical Screening*, advocated the careful usage of screening-related terms to “avoid confusion and suspicion” [3]. Because screening is voluntary and cannot work without volunteers, avoiding suspicion should be a high priority both for clinical and public health professionals. Avoiding confusion is also essential because the methodologies involved in determining whether screening does more good than harm are quite complex and prone to misunderstanding by members of the public [4,5]. For example, regarding cancer screening, people

typically overestimate the positive effects, and underestimate the potential for harm [6]. Over-promotion of mammography may have led to unrealistic expectations, which may now be causing fears of vexatious litigation among some clinicians [7]. Breast cancer screening guidelines seem especially prone to regular revision, resulting in conflicting recommendations across jurisdictions and even between governmental agencies and cancer agencies. While screening-as-early-detection seems widely understood and intuitive, communicating the complexities of evaluating the full range of risks and benefits of screening is difficult. Clearly, it is appropriate for us to change screening recommendations in the face of newer, better evidence. But, paradoxically, every time our guidelines are updated to reflect the latest evidence, the public’s confidence that we know what we are doing, may be eroded.

The purpose of this paper is to understand the different concepts about screening by reviewing definitions and examples of screening in selected public health and epidemiology textbooks, dictionaries, and relevant journal publications. Our aim was to identify common usages and concepts, sources of potential misunderstanding, and the fundamentals of screening about which the public deserves to receive clear explanations.

MATERIALS AND METHODS

Two main approaches were used for data search. First, using search engines and academic databases at Western University, we searched peer reviewed journals and then books, on epidemiology and public health. The search platforms used were Pubmed, BIOSIS, EMBASE, Medline-OVID, and Scopus under the Epidemiology and Biostatistics subject head listed with Life Sciences. The following

search terms were used, as single terms and in combinations using “and” and “or”: surveillance, screening, selective screening, public health, mass screening, mass public health screening, definition of screening, ethics of screening and clinical screening. The results were limited to publications in English which were available during the period from June 2014 to January 2016. Our objective was not to systematically locate every published definition and example, but rather to gather a representative sample of published usage of screening terminology in well-known textbooks and journals.

RESULTS

The search located seven journal articles [1,3,8-12] and ten textbooks [2,5,13-20], and one dictionary [21]. What screening is, and is not, depended on: whether screening is seen as a program or as a test; the setting or context in which it is done; eligibility criteria; who requests or initiates the screening; who is expected to benefit; whether the entity screened for is a chronic disease, a communicable disease, or an elevated risk state, and the level of prevention/stage of natural history at which screening is performed [16].

Common characteristics – what screening is, and is not: For the most part, both public health and clinical explanations of screening had the following aspects in common: i) one or more observations (procedures, tests, examinations) offered to presumptively healthy (asymptomatic) people; ii) to detect something putatively prognostic (risk factor, precursor, or occult pathology); iii) under the assumption that early detection will be followed by prompt efficacious intervention; iv) that will alter natural history and improve the screened individual's outcome (e.g., longer survival, fewer complications, higher quality of life) relative to not having been screened.

Beyond the above, we found that the definitions, and, especially, the examples and explanations of what screening is and is not, differed considerably. For example, some public health and medical screening authors excluded tests for fitness for employment [3,5,14,15]. Raffle and Gray saw “lifestyle checks and fitness testing” as part of health promotion, not screening [5]. Epidemiological research, purely to estimate the population prevalence either of risk factors or of disease, such as anonymous HIV seroprevalence studies [3] was explicitly excluded from medical screening, although earlier authors noted the potential for prevalence studies to find cases [1,16].

In a book aimed at those in public health practice and policy [5], Raffle and Gray excluded hospital-based ‘safety checks’ such as pre-surgical liver function tests. They also excluded check-ups for insurance purposes, which Webb P et al., included [17]. Raffle and Gray considered tests to discover infectious carriers as part of infection control, not screening [5]. Conversely, detection of infectious or communicable diseases was an example of screening in several texts: “testing for acute communicable diseases (e.g., rubella)” [18], HIV and hepatitis B in immigrants, SARS and H1N1 in travellers [17], and tuberculosis in prison inmates [15].

Screening programs vs. screening tests-systematic vs. ad hoc: Public health authors, particularly Raffle and Gray, emphasized the importance of defining screening as an organized, systematic program (e.g., for breast or cervical cancer), not as a test (e.g., mammogram, Pap smear) [5]. As such, ad hoc clinical case-finding like checking all patients for hypertension [19,21] would qualify as a screening program only if it was uniformly applied by all primary care practitioners, and included standard follow up of all who screened positive. An important epidemiological consideration is that organized population-based programs are easier to evaluate because of more complete knowledge of the denominator – the population intended to benefit from the program – than is typically the case with ad hoc testing.

Setting of screening, who initiates screening, and who is expected to benefit: Screening that occurs in non-clinical

community setting is often initiated by the person being screened. Examples include glaucoma screening at the county fair ‘health-rama’ [19] and direct-to-consumer genetic testing [8]. By contrast, Wald N defined medical screening as something that is normally “initiated by medical authorities” [9], and Porta M state the initiative usually comes from “an agency or organization” [21]. Authors of medical screening definitions emphasize that screening is “intended to benefit the individuals being screened” and explicitly exclude “mass testing, that pose(s) a threat to those who are tested” such as examinations of suitability for employment, along with tests that have a “policing function” [3]. By contrast, Webb P et al., included regular testing of airline pilots as an example of screening [17]. Benefiting those screened would appear not to be the major aim of scanning for febrile passengers in airports [10,17] particularly when the causes of the fevers are incurable microbes with pandemic potential. Raffle AE and Gray JAM defined contact tracing of infectious persons as part of infection control, not screening [5]. While the Dictionary of Epidemiology [21] stated that screening is “usually concerned with chronic diseases”, one meaning of case-finding in that book is a synonym for contact tracing, “a standard procedure in the control of certain infectious diseases” such as “tuberculosis and sexually transmitted diseases.” As noted above, however, case-finding is also used to refer to ad hoc screening for conditions such as hypertension [19,21]. Fitting genetic screening into these definitions is especially problematic. Raffle AE and Gray JAM stated “Genetic screening (is) a term that is widely used but has no specific meaning and should not be used [5]”. The Dictionary of Epidemiology lists “genetic predisposition” as an example of a screening target, even though the identification of gene mutations that are penetrant for incurable terminal conditions cannot by itself benefit the screenee by enabling a head-start on therapy [21]. Raffle and Gray's solution is to include in their definition of screening the provision of “information about risk that is deemed valuable” for the screened individual “even though risk cannot be altered” [5].

Stage of natural history: In both classical and clinical epidemiology, screening is a key part of secondary prevention, defined as “a set of measures for the early detection and prompt intervention to control disease and minimize disability” [21]. ‘Early detection’ implies that pathological changes are underway and detectable, but not yet symptomatic. The early detection of occult disease followed by prompt intervention is the rationale of breast and colorectal cancer screening programs, which stand out as archetypes of population-based screening programs that span public health and clinical medicine. However, screening can also be done for “risk factors” [13,21] which can be “physical or behavioural attributes” even though recently adopted risk-increasing behaviours such as tobacco smoking [17], will not typically be accompanied by detectable pathological changes. When screening is done before there are detectable tissue changes, we are necessarily working at the level of primary prevention, examples of which include “decreasing environmental risks, enhancing nutritional status, immunizing against communicable diseases, or improving water supplies” [21]. Finally, when screening is done to identify people at increased risk for injuries or problematic deliveries, there may not even be any occult disease in the sense of a malignant tumour, making it difficult or impossible to map the levels of prevention onto the stages of natural history.

Types of screening: Raffle AE and Gray JAM stated that screening programs can be categorized according to their aims [5]. As originally categorized by McKeown [16], screening was done for epidemiological research, public protection, and to benefit the person screened (the latter which McKeown called ‘prescriptive’ screening) [5]. There now appear to be four main aims of screening, although seven terms are used to describe them: case-finding, mass screening, multiphasic screening, opportunistic screening, periodical health examination, prescriptive screening, and targeted screening.

Case finding and opportunistic screening: The common characteristic of case finding mentioned by most authors is that it is usually done as part of a clinical encounter for some other health condition [18,19,21], although the provided examples differ. Raffle AE and Grey JAM stated it is “difficult to define as it tends to be used rather vaguely. It can mean finding cases in known high risk individuals” [5]. Opportunistic screening and case finding are used synonymously by some authors [14,15] whereas opportunistic screening is not mentioned by Porta M [21], Raffle AE and Grey JAM [5], or Wald NJ [3,9].

Mass screening approaches the level of the population, or major demographic subgroups such as “all adults” [1] or “young children” [2]. Testing for Phenylketonuria in neonates [15] mandatory dental screening [22], and vision screening in school children [15] are provided examples. The key feature is that eligibility is very broad and not based on factors associated with increased risk of the health condition of interest.

Selective screening and targeted screening: Selective and targeted screening are used synonymously by Friis RH and Sellers PA and Oleckno WA [14,15]. The key distinguishing feature from mass screening is that eligibility is based on a characteristic associated with increased risk of the condition being detected such as occupation [1] or ethnicity [14].

Multiphasic screening vs. periodic health examination: The fundamental aspect of multiphasic screening, agreed on by all authors, is that more than one test is applied for more than one condition, although there are important differences. For example, to Whitby LG [1], mass and selective screening programs can also be multiphasic, and to Oleckno WA [15], so can mass, selective and opportunistic screening. Porta M, however, indicated that the multiple tests need not all be administered concurrently, which raises the question of whether there is a minimum inter-test time interval after which multiphasic screening becomes a series of ad hoc screening tests [21]. Friis RH and Sellers TA and Oleckno WA list pre-employment and pre-military physicals as examples of multiphasic screening [14,15], and Sackett DL et al., give the ‘healthorama’ booth at the county fair as their example [19]. The distinction between multiphasic screening and periodic health examinations is not entirely clear; Sackett DL et al., description of the periodic health examination mentions multiple testing [19], whereas, Raffle AE and Gray JAM merely indicated the regular timing [5].

Surveillance: Understanding what surveillance is might help us understand what screening is not. Several definitions and examples of surveillance have been published. Raffle AE and Grey JAM defined surveillance as “hard to define, but generally used to mean keeping an eye on things” [5]. Wald NJ recommends the term surveillance for activities such as anonymous sero-prevalence studies for conditions such as HIV [3]. The Oxford Handbook of Public Health Practice lists the objectives of surveillance as an early warning system for disease outbreaks or changes in incidence (e.g., of tuberculosis), to identify high risk groups (e.g., neonates who might benefit from BCG vaccination) and to evaluate the effectiveness of interventions (e.g., new vaccines) [20]. The preponderance of communicable disease examples listed under surveillance is further evidence of a shift among authors away from communicable diseases as targets of screening tests or programs. There is not yet a consensus that screening is for chronic diseases, and that the use of scanners to detect febrile passengers at airports should be called surveillance [17]. Interestingly, however, this shift in usage from airport passenger ‘screening’ to ‘surveillance’ recently occurred over a short time period in one infectious disease journal [11,12].

DISCUSSION

Whitby LG’s observation over four decades ago about terminological looseness around ‘screening’ seems at least as accurate today [1]. If we are to help both the public and policymakers understand the

evidence about the risks and benefits of screening, we need to first agree among ourselves why we screen, and what screening is and is not.

Screening programs, screening tests, assessments of elevated risk states, and surveillance programs for infection control differ in their stated aims, how they are evaluated, their ethics considerations and policy implications. Published descriptions of ‘types’ of screening are confusing and sometimes contradictory [23-25]. Perhaps the typology approach should be replaced by evidence-based operational details of screening programs that would keep the focus on evaluation: clearly stated outcomes, target population, eligibility criteria, type and frequency of tests, risks and benefits, and cost effectiveness.

Wald M reminds us that the early detection of disease should not be an end in itself, and that the “value of a screening test needs to be determined before it is introduced into practice” [3]. Raffle AE and Grey JAM emphasized the importance of evaluating screening programs for their ability to do more good than harm at the population level [5]. But the automatic value of early detection seems to be so strongly held as an article of faith that is difficult to inoculate the public against the Popularity Paradox: “The greater the harm through over diagnosis and overtreatment from screening, the more people there are who believe they owe their health, or even their life, to the programme [5]”. Exerting control over one’s health by becoming aware of modifiable risk factors is a crucial part of health promotion. However, the public health profession does have an ethical obligation to communicate to the public the risks as well as the benefits of ‘screening’ in all its forms. Because knowledge is power, perhaps the most empowering thing we can do for policymakers and citizens is to take every opportunity to teach them why and how “all screening programmes do harm, some do good as well” [5].

CONCLUSION

Future public health screening programs should be developed with strong focus on consistency in terminology and clarity in definition. This continued review of key concepts and practices of public health serves as a cornerstone in maintaining the public health programs effective, safe and relevant. This continued effort also helps to maintain high cognitive domain in knowledge acquisition, synthesis, analysis, application and evaluation with concepts and practices of public health screening.

REFERENCES

- [1] Whitby LG. Screening for disease: definition and criteria. *Lancet*. 1974;ii:819-22.
- [2] Pellerito JS, Polak JF. Introduction to vascular ultrasonography. Philadelphia, PA: Elsevier/Saunders, 2012.
- [3] Wald NJ. Editorial. *J Med Screen*. 1994;1:1-2.
- [4] Cockburn J, Redman S, Hill D, Henry E. Public understanding of medical screening. *J Med Screen*. 1995;2(4):224-27.
- [5] Raffle AE, Gray JAM. Screening: Evidence and practice. *Int J Epidemiol*. 2009;38(6):1748-49.
- [6] Schwartz LM, Woloshin S, Fowler FJ, Jr, Welch HG. Enthusiasm for cancer screening in the United States. *JAMA*. 2004;291:71-78.
- [7] Mavroforou A, Mavroforos D, Michalodimitrakis E. Screening mammography, public perceptions, and medical liability. *Eur J Radiol*. 2006;57(3):428-35.
- [8] Hudson K, Javitt G, Burke W, Byers P. ASHG statement on direct-to-consumer genetic testing in the United States. *Am J Hum Genet*. 2007;81(3):635-37.
- [9] Wald NJ. Guidance on terminology. *J Med Screen*. 1994;1:76.
- [10] Shu PY, Chien LJ, Chang SF, Su CL, Kuo YC, Liao TL, et al. Fever screening at airports and imported dengue. *Emerging Infectious Diseases*. 2005;11(3):460-62.
- [11] Nishiura H, Kamiya K. Fever screening during the influenza (H1N1-2009) pandemic at Narita International Airport, Japan. *BMC Infect Dis*. 2011;11:111.
- [12] Kuan M, Chang F. Airport sentinel surveillance and entry quarantine for dengue infections following a fever screening program in Taiwan. *BMC Infect Dis*. 2012;12:182.
- [13] Baum F, *The New Public Health*, Edition 2, Oxford University Press. 2002:315.
- [14] Friis RH, Sellers TA. *Epidemiology for public health practice*. Sudbury, Mass: Jones and Bartlett Publishers, 2009.
- [15] Oleckno WA. *Epidemiology – Concepts and methods*. Long Grove IL: Waveland Press, 2008.

- [16] McKeown, T. [ed.] Screening in medical care: reviewing the evidence, a collection of essays. London UK: Oxford University Press, 1968.
- [17] Webb P, Bain C, Pirozzo S. Essential epidemiology: An introduction for students and health professionals. Cambridge, UK: Cambridge University Press; 2005.
- [18] Cassen BJ; Preventive Medicine and Public Health; 2nd Ed.; The National Medical Series for independent study.
- [19] Sackett DL. Clinical epidemiology: A basic science for clinical medicine. Boston: Little, Brown; 1991.
- [20] Hadden F, O'Brien S. Assessing acute health trends: surveillance. Ch. 1.2 in Pencheon D, Guest C, Melzer D, Gray JAM.(eds). Oxford Handbook of Public Health Practice. Oxford: Oxford University Press 2001.
- [21] Porta M. A Dictionary of Epidemiology. New York: Oxford University Press. 2008:224.
- [22] David L. Prevalence of traumatic dental injury in grade 8 children in six Ontario Communities. Can J Public Health. 2005;96(1):73-76.
- [23] Wald NJ, Oppenheimer P. Discounting financial costs and health benefits in public health programs. J Med Screen. 2016;23(3):115.
- [24] Farmer J, McLeod L, Siddiqi A, Ravaghi V, Quiñonez C. Towards an understanding of the structural determinants of oral health inequalities: A comparative analysis between Canada and the United States. SSM – Population Health. 2016;2:226-36.
- [25] Ripping TM, Verbeek ALM, Broeders MJM. Over diagnosis in cancer screening: the need for standardised denominator. J Med Screen. 2016;23(2):111-13.

PARTICULARS OF CONTRIBUTORS:

1. Professor, Department of Epidemiology and Biostatistics, Western University, London, Ontario, Canada.
2. Research Associate, Department of Public Health, Western University, London, Ontario, Canada.
3. Associate Professor, Department of Public Health Dentistry, Mar Baselios Dental College, Kothamangalam, Ernakulam, Kerala, India.
4. Associate Professor, Department of Oral and Maxillofacial Surgery, Malabar Dental College and Research Centre, Edappal, Malappuram, Kerala, India
5. Professor, Department of Orthodontics, Annoor Dental College and Hospital, Ernakulam, Kerala, India.
6. Professor, Department of Oral and Maxillofacial Surgery, Annoor Dental College and Hospital, Ernakulam, Kerala, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Eby Aluckal,
Associate Professor, Department of Public Health Dentistry, Mar Baselios Dental College, Kothamangalam,
Ernakulam-686691, Kerala, India.
E-mail: draluckal@gmail.com

Date of Submission: **Oct 15, 2016**Date of Peer Review: **Nov 05, 2016**Date of Acceptance: **Jan 05, 2017**Date of Publishing: **Mar 01, 2017****FINANCIAL OR OTHER COMPETING INTERESTS:** None.