Screening Criteria

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Introduction

- “Can we use an MRI as a screening test for all diseases?”
- “Should we screen every person for every disease, just in case?”
- “Why not do a full-body scan every year for everyone above 30?”

"Imagine you're a junior doctor and a 30-year-old asymptomatic man walks in and says, ‘Doctor, I want to do all possible tests—even MRI, PET scan, cancer markers—just to be safe.’
What will you tell him?

Would you go ahead with it? Or will you explain why that may not be a good idea?"

Introduction

“We can’t screen for all diseases, and we can’t use every test as a screening tool.

Screening needs to follow strict criteria—scientific, ethical, and economic.

These are called **Screening Test Criteria**, best laid out by **Wilson and Jungner in 1968** and still followed globally.”

Criteria for Disease Screening

1. The condition should be an important health problem.

Example: Screening for cervical cancer is justified because it's a leading cause of death in women.

2. There should be a recognizable latent or early symptomatic stage.

Example: Diabetes has a prediabetic stage.

3. The natural history of the condition should be adequately understood.

Example: The progression of hypertension to heart failure is well known.

Criteria for Disease Screening

4. There should be a suitable test or examination.

Example: Pap smear is a suitable test for cervical cancer.

5. The test should be acceptable to the population.

Example: Colonoscopy may have low acceptability; FIT test is better accepted.

6. There should be an agreed policy on whom to treat as patients.

Example: Clear thresholds for treating high fasting blood sugar.

7. There should be an accepted treatment for patients with recognized disease.

Example: Treating early-stage breast cancer improves survival.

Criteria for Disease Screening

8. Facilities for diagnosis and treatment should be available.

Example: No use screening for TB if DOTS centers aren't functional.

9. The cost of case-finding (including diagnosis and treatment) should be economically balanced in relation to possible expenditure on medical care as a whole.

Example: Mammography in women aged 50–69 is more cost-effective than in women aged 30.

10. Case-finding should be a continuing process and not a 'once and for all' project.

Example: Annual screening for diabetes in high-risk groups.

Wilson and Jungner Criteria	Suitable Disease Example	Non-Suitable Disease Example
1. Important health problem	Hypertension	Tennis elbow
2. Recognizable latent/early stage	Cervical cancer (pre-cancerous stage)	Pancreatic cancer (often no early stage)
3. Natural history well understood	Type 2 Diabetes Mellitus	Alzheimer's disease (still unclear progression and etiology)
4. Suitable test available	Pap smear for cervical cancer	No reliable test for early-stage ovarian cancer
5. Test acceptable to population	Blood pressure measurement	Colonoscopy (low acceptability in general population)
6. Agreed policy on whom to treat	Fasting blood sugar >126 mg/dL treated as diabetes	No clear guidelines for treatment of mild cognitive impairment
7. Accepted effective treatment available	Antihypertensives for high BP	No effective cure for advanced ALS (amyotrophic lateral sclerosis)
8. Facilities for diagnosis and treatment are available	DOTS centers for TB treatment	Lack of oncology services in rural areas for advanced cancers
9. Cost of case finding is economically balanced	Blood glucose testing is cheap and cost-effective	Whole-body MRI for general population is expensive and low-yield
10. Case finding should be continuous	Annual mammography for breast cancer	One-time genetic screening with no follow-up plan

Criteria for Tests

The test must satisfy the following criteria to consider as screening test

- **Acceptability**
- **Repeatability**
- **Validity (Sensitivity, Specificity)**
- **Yield**
- **Simplicity, Safety, Rapidity**
- **Ease of administration and cost**

Acceptability

Acceptability refers to how **willing and comfortable people are to undergo** a screening test, considering factors like

pain,

time,

privacy,

social stigma,

cultural beliefs,

and **logistics**.

Acceptability Factors

Factor	Examples of High Acceptability	Examples of Low Acceptability
Invasiveness	Blood pressure check, height/weight	Colonoscopy, Pap smear
Pain or Discomfort	Fasting blood glucose	Mammography (can cause discomfort)
Time Required	Spot blood sugar, BP check	2-hour OGTT, endoscopy
Privacy/Social Sensitivity	Hemoglobin estimation	HIV screening, Pap smear in conservative settings
Cultural Beliefs	Routine anthropometry	Digital rectal exam, STI screening in conservative societies
Cost to Patient	Free BP screening camps	Self-paid MRI screening
Awareness and Health Literacy	Cervical cancer screening in educated women	Same test refused in low-literacy areas
Frequency of Test	Blood pressure check	Annual colonoscopy

How to Improve Acceptability

- Use **non-invasive or minimally invasive** methods (e.g., oral swabs instead of blood draw).
- Ensure **privacy and confidentiality**, especially for sensitive conditions.
- Provide **clear explanation and counseling** before and after the test.
- Offer **free or subsidized screening**.
- Involve **community health workers or peer educators** to build trust.
- Respect cultural norms and gender preferences (e.g., female staff for female exams).

Repeatability

Repeatability (also called **reliability**) refers to the **ability of a test to give consistent results when repeated** under the same conditions — same person, same method, same observer.

1. Ensures **trust in results**
2. Reduces **false positives/negatives**
3. Enables **monitoring over time**
4. Improves **clinical decisions and follow-up**

Test	Repeatability
Hemoglobin via Autoanalyzer	High
Visual Acuity with Snellen Chart	Moderate
Urine dipstick (manual)	Low

Repeatability

Aspect	Explanation	Example (Good)	Example (Poor)
Intra-observer Repeatability	Same observer gets the same result when repeating the test	Digital BP monitor used by same person	Manual breast exam (depends on technique)
Inter-observer Repeatability	Different observers get similar results	HbA1c estimation via automated machine	Chest X-ray interpretation (varies between radiologists)

Repeatability

Aspect	Explanation	Example (Good)	Example (Poor)
Instrument Consistency	Different equipment or kits yield same results	Automated glucometer	Urine dipstick with color chart
Standardized procedures	Following Standard operating procedures	Pap smear using liquid-based cytology	Physical examination without protocol
Minimal biological variability	Variation of test results because of biological changes in the person undergoing test	HbA1c (long-term glucose control, less day-to-day variation)	Fasting blood glucose (affected by diet, stress, sleep), ECG with labile arrhythmias

To improve repeatability

1. Use **automated instruments** over manual tests.
2. Train staff with **standard operating procedures (SOPs)**.
3. Calibrate equipment regularly.
4. Avoid tests with high **inter-observer or intra-observer variation**.
5. Use **objective tests** instead of subjective interpretation.

Validity of Test

Sometimes, A test may be **highly repeatable but still not valid** (accurate).

Ex: A Weighing scale that is 5 kg off will always give the same wrong value — reliable but not valid.

So What is Validity of test?

Validity refers to **how accurately** a screening test **identifies those with and without the disease**. **A test with high validity gives the correct result most of the time.**

Validity of Test

Component	Definition	Example
SeNsitivity	Ability of test to detect true positives	HIV ELISA test has sensitivity >99%
SPecificity	Ability of test to detect true negatives	HIV Western Blot has high specificity >99% . Used as Confirmatory test after a positive HIV ELISA

🧠 **Mnemonic:**

SeNsitivity – Positive cases

SPecificity – Negative cases

2×2 Table for Test Validity

	Disease Present	**Disease Absent**
Test Positive	True Positive (TP)	False Positive (FP)
Test Negative	False Negative (FN)	True Negative (TN)

- **Sensitivity = TP / (TP + FN)**
- **Specificity = TN / (TN + FP)**
- **Positive predictive value = TP / (TP + FP)**
- **Negative predictive value = TN / (TN + FN)**
- **Proportion of false negatives = FN / (TP + FN)**
- **Proportion of false positives = FP / (FP + TN)**

Validity of Test

Feature	**Simultaneous (Parallel)**	**Sequential (Serial)**
Number of tests	All at once	One after another
Positive result	Any test positive	All tests positive
Sensitivity	Increases (↑) $1 - [(1 - \text{Sensitivity}_1) \times (1 - \text{Sensitivity}_2)]$	Decreases (↓) $\text{Sensitivity}_1 \times \text{Sensitivity}_2$
Specificity	Decreases (↓) $\text{Specificity}_1 \times \text{Specificity}_2$	Increases (↑) $1 - [(1 - \text{Specificity}_1) \times (1 - \text{Specificity}_2)]$
Use when	Missing disease is risky	False positives are costly
Example	ELISA + Rapid HIV test	Fasting Blood Sugar → HBA1C

Yield of Test

Yield refers to the **number of previously undiagnosed cases of a disease** that are **detected** by the screening process **in a defined population**.

Type	Meaning	Example
Initial yield	Number of cases found in first round	First-time cervical cancer screening in a district
Subsequent (periodic) yield	Number of new cases found in repeat rounds	Annual diabetes screening in high-risk adults
Corrected yield	Yield after adjusting for false positives	True new cases after confirmatory test
Net yield	Cases found minus cases that would have been diagnosed anyway soon (lead-time adjusted)	Adjusts for early but not useful detection

Factors Affecting Yield

- Higher prevalence → higher yield
- Higher sensitivity → higher yield
- Larger number → higher absolute number of cases found
- Frequent testing may lower yield per round but increase cumulative detection
- Screening high-risk groups gives higher yield than general population

ROC Curve

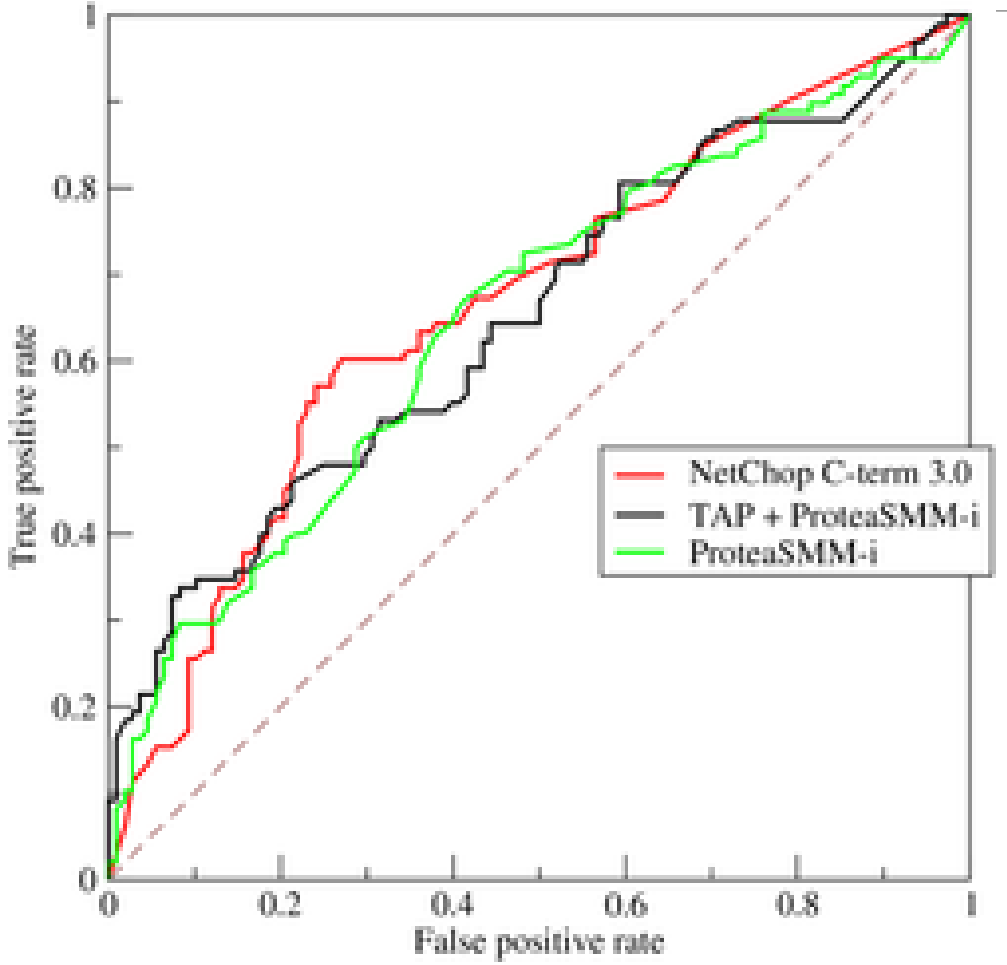
The **ROC curve** is a **graphical tool** used to evaluate the **diagnostic accuracy** of a screening test, especially when you can **adjust the threshold** (cut-off) value.

X-axis = 1 − **Specificity** (False Positive Rate)

Y-axis = **Sensitivity** (True Positive Rate)

Each point on the ROC curve represents a **different cut-off value** for a test.

ROC Curve



Closer to top-left corner

Better test (high sensitivity & specificity)

Curve near diagonal line

Poor test (no better than random guess)

Area under the curve (AUC)

Single number representing test's overall accuracy

Problem of Borderline

The **problem of borderline** refers to the **uncertainty in classifying test results** that lie **close to the diagnostic threshold**—not clearly positive, not clearly negative.

Example Scenario:

Fasting Blood Sugar:

- Normal: <100 mg/dL
- Diabetes: ≥126 mg/dL
- **Borderline zone (Prediabetes): 100–125 mg/dL**

  → Not diabetic, but not normal either.

Borderline results highlight the **limitations of dichotomizing** a continuous variable (like glucose, BP) into just "positive" and "negative."

How to manage borderline problems

Strategy	Purpose
Use a **gray zone**	Label results as indeterminate or borderline and follow with more specific testing
Apply **repeat testing**	Confirm result after some time (e.g., 2 fasting readings or OGTT)
Combine with **clinical criteria**	Don’t rely solely on test result—assess risk factors, symptoms
Use **multiple tests or scoring systems**	Example: combine BMI, HbA1c, and glucose to assess diabetes risk

Antenatal Screening tests

Test	When	Why	Threshold / Action
Hemoglobin (CBC)	At registration, 24–28 wks	Screen for anemia	Hb <11 g/dL → treat
Blood Group & Rh typing	At registration	Prevent Rh incompatibility	Rh-negative mother → Anti-D at 28 weeks & delivery
Blood sugar (OGTT)	24–28 weeks (or earlier if high risk)	Gestational diabetes	75g OGTT: 2h >140 mg/dL = GDM
Urine albumin/sugar	Each visit	Preeclampsia/UTI/DM	Proteinuria or glucosuria → further testing
VDRL/RPR	At registration	Syphilis	Positive → treat with penicillin
HBsAg	At registration	Hepatitis B transmission risk	Positive → neonatal immunoprophylaxis
HIV test	At registration & 3rd trimester	Vertical transmission	Positive → ART + prevent transmission
Thyroid function (TSH)	First trimester	Screen for hypothyroidism	TSH >2.5 µIU/mL (1st trimester)

Infant Screening tests

Test	When	Why	Threshold / Action
Newborn screening (heel prick)	48–72 hrs after birth	Congenital hypothyroidism, G6PD, PKU	TSH >10 µIU/mL → retest/confirm
Physical exam (heart, hips, testes, palate)	Birth, 6 wk, 6 mo	Detect congenital anomalies	Any abnormality → refer
Hearing screening (OAE/ABR)	Before 1 month	Early hearing loss	Refer if failed
Vision assessment	At 6 weeks onward	Detect congenital cataract, strabismus	Abnormal red reflex → urgent referral
Growth monitoring (Wt, Ht, HC)	Every visit	Malnutrition, failure to thrive	Plot on WHO growth chart
Developmental screening	6 wk, 6 mo, 9 mo	Milestones delay	Delay in 2+ domains → refer
Hemoglobin	6 months (in high-risk areas)	Iron-deficiency anemia	Hb <11 g/dL

Middle aged adults Screening tests

Test	When	Why	Threshold / Action
Blood pressure	Every 1–2 years	Hypertension	≥140/90 mmHg on 2 readings
Fasting blood glucose / HbA1c	Every 3 years (age >40 or risk factors)	Diabetes	FBG ≥126 mg/dL or HbA1c ≥6.5%
Lipid profile	Every 5 years (age >40)	Cardiovascular risk	LDL >100 mg/dL in high-risk
Pap smear (women)	Every 3 years from age 21–65	Cervical cancer	Abnormal → colposcopy
Breast exam (clinical)	Every 3 years (age 30–40), annually after 40	Breast cancer	Lump → imaging/biopsy
Mammogram	Every 2 years (age 50–69)	Breast cancer	Suspicious lesion → biopsy
Colon cancer screening (FOBT/FIT)	Age ≥50, every 1–2 years	Colorectal cancer	Positive → colonoscopy
Oral exam (especially in tobacco users)	Annually	Oral cancer	White patch → biopsy
Eye check (vision + fundus)	Every 2 years	Refractive error, diabetic retinopathy	Refer as needed

Geriatric adults Screening tests

Test	When	Why	Threshold / Action
Blood pressure	Annually	Hypertension	Treat if ≥140/90 mmHg
Blood glucose / HbA1c	Annually	Diabetes	As above
Lipid profile	Every 3–5 years	CAD risk	Target LDL <70 if high-risk
Vision test (Snellen + Fundus)	Annually	Cataract, glaucoma, retinopathy	Refer if abnormal
Hearing assessment	Annually	Presbycusis	Audiometry if complaints
Bone mineral density (DEXA scan)	Once after 65 (women), 70 (men)	Osteoporosis	T-score ≤ −2.5
Cognitive screening (MMSE/MoCA)	Annually	Dementia	MMSE <24/30 → further workup
Depression screening (GDS)	Annually	Geriatric depression	GDS >5 → assess
Fall risk assessment	Annually	Prevent injury	Positive → home safety, PT

Evaluation of Screening programs

Evaluating a screening program means assessing **how effective, efficient, and ethical** the program is in achieving its public health goals.

This includes checking both **process** (how it's implemented) and **outcome** (what impact it has).

Coverage	>80% desirable
Participation Rate	>70% is good
Yield	10/1000 screened (example for diabetes)
Sensitivity	>80% ideal
Specificity	>90% ideal
Detection rate	Varies by disease

Evaluation of Screening programs

Study Design	Causality	Feasibility	Use Case
RCT	Strong	Low	New screening intervention
Uncontrolled Trial	Weak	High	Pilot program
Non-Randomized Control	Moderate	Moderate	Field-level comparisons
Case-Control	Moderate	High	Rare disease outcomes
Cohort	Moderate	Moderate	Natural history evaluation
Ecological	Weak	Very High	Policy-level comparisons

Conclusion

Screening is a cornerstone of preventive medicine, but its application demands meticulous adherence to established criteria.

Not every disease is fit for screening, and not all tests are worth implementing.

The balance of **cost-effectiveness, test validity, acceptability, and health infrastructure determines the success of any screening program**.

As public health systems advance, tailoring screening strategies to demographic and cultural realities will ensure that **early detection translates into tangible health outcomes.**

Thank You