REDUCING DIAGNOSTIC ERROR IN MEDICINE

BY BREAKING THE DIAGNOSTIC AND EPIDEMIOLOGIC FEED FORWARD LOOP

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1. Describe how diagnostic tests may influence the prevalence of a disease. 2. Explain how, by increasing apparent prevalence, a test may influence apparent its apparent diagnostic power. 3. Show how the cycle of increasing test sensitivity and screening leads to an increase in Diagnostic Error in Medicine.

SITUATION

The power of screening and diagnostic tests is dependent on factors that influence the maximum sensitivity and specificity that can be achieved. However, it is the prevalence of a disease that determines the Positive Predictive Value [**PPV**] and Negative Predictive Value [**NPV**] of a test, and so, the total number of false positive and false negative diagnoses.

Unfortunately, epidemiologic data used to estimate prevalence is often based on the results of the test itself. And this data influences clinical judgment, societal behavior, and public policy. In turn, this leads to a paradox whereby the test initiates a feed forward cycle of increased perceived reliability, increased use, and, falsely increased prevalence.

PROBLEM

How can we

RISK	*Maximize patient safety* through collection of accurate and precise epidemiologic data regarding test reliability
QUALITY	*Minimize* discomfort and the pain *suffered* due to over diagnosis and treatment due to wrong epidemiologic data
UTILITY	*Minimize expenditure* of scarce resources by improving the reliability of epidemiologic data based on diagnostic tests

SOLUTION

It is proposed that the present feed forward cycle can be broken through the establishment of **epidemiologic trials**. These would be designed along the lines of clinical trials whereby the clinical test modality and the diagnostic decision making process by which the modality is utilized are evaluated prior to general deployment through statistical modeling and by assessing clinical outcomes in an adequate number of patients.

This approach will, at the very least, delay the general implementation of a flawed clinical testing modality or diagnostic decision making process thereby avoiding the corruption of epidemiologic data used to develop clinical guidelines, influence societal attitudes, and formulate public policy.

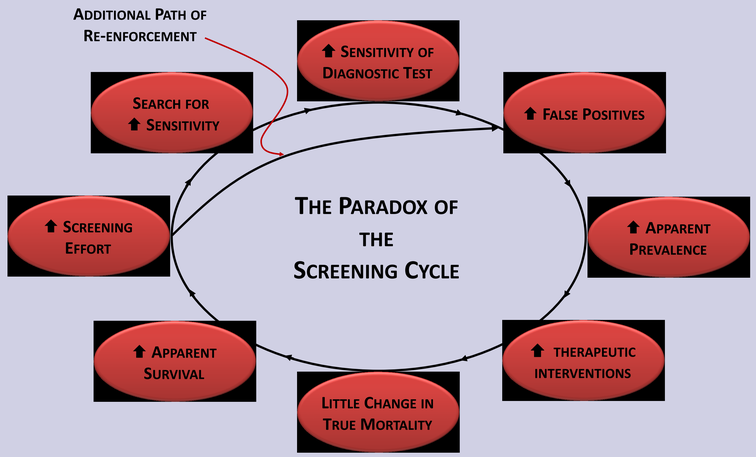
IMPLEMENTATION

A literature search was carried out to identify diseases where prevalence has risen while the death rate has stayed the same or dropped slightly. These were studied to determine how test characteristics might have influenced reported disease prevalence. Several were identified including breast cancer, thyroid cancer, prostate cancer, and malignant melanoma.

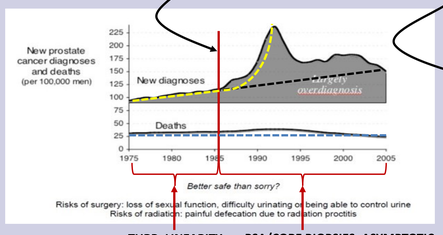
An MS Excel spreadsheet was developed to model the impact rising rates of screening can have on apparent prevalence through rising false positive diagnoses. The spreadsheet data was then plotted and compared to epidemiologic data of actual screening efforts; in this case prostate cancer. Changing rates of sensitivity and mortality were excluded for simplicity.

THE EPIDEMIOLOGIC FEED FORWARD LOOP

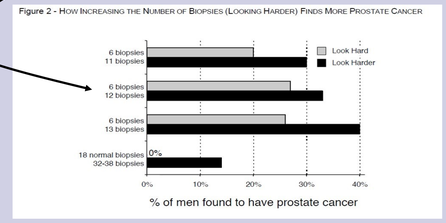
EXAMPLE EIGHT PHASE CYCLE

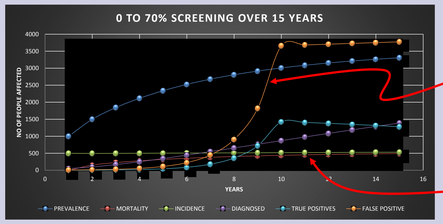


⬆ SCREENING + [⬆SENSITIVITY ➡ ⬇SPECIFICITY] ➡ FALSELY ⬆ APPARENT PREVALENCE



TURP: LINEARITY PSA/CORE BIOPSIES: ASYMPTOTIC





NOTE: EVEN WITH FIXED SENSITIVITY, AS SCREENING OF A TARGETED POPULATION RISES FROM 0 TO A SUSTAINED 70%, THE *APPARENT* PREVALENCE [MOSTLY FALSE POSITIVES] OF THE DISEASE RISES ASYMPTOTICALLY TO A PEAK AND THEN DROPS BACK ONCE THE MAXIMUM HAS BEEN ACHIEVED. DEPENDING ON MORTALITY RATE DUE TO THE DISEASE, IT BEGINS TO FALL.

WHEREAS, THE MORTALITY RATE DOES NOT CHANGE SIGNIFICANTLY, EVEN IN THE ABSENCE OF THERAPY AS SHOWN IN THIS PARTICULAR EPIDEMIOLOGIC MODEL.

SIMPLIFIED EPIDEMIOLOGIC MODEL OF A POPULATION AFFLICTED BY ONLY ONE DISEASE WITH NO THERAPEUTIC INTERVENTION

POPULATION	POP GROWTH	INCIDENCE	PREVALENCE	MORTALITY	% DIAG		FINAL SCREEN		SENSITIVITY	SPECIFICITY							
100000	0.01	0.005	0.01	0.15	0.05		70.00%		0.95	0.95							
					False +/- for Diag not included												
YEAR	POPULATION	INCIDENCE	PREVALENCE	MORTALITY	DIAGNOSED	% DIAG	ACCEPTANCE	SCREENED	TRUE +	TRUE -	FALSE +	FALSE -	TOTAL +	TOTAL -	PPV	NPV	F+/T+
1	100000	500	1000	0	50	5.00%	0.14%	137	1	129	7	0	58	129	2.13%	99.95%	5.49
2	101000	495	1500	150	98	6.50%	0.27%	276	4	259	14	0	115	259	3.17%	99.93%	3.74
3	101860	498	1845	225	168	9.09%	0.55%	556	9	520	27	0	204	521	4.28%	99.91%	3.14
4	102654	500	2118	277	251	11.88%	1.09%	1120	19	1047	55	1	326	1048	5.95%	99.90%	2.84
5	103403	503	2341	318	345	14.73%	2.19%	2254	41	2107	111	2	497	2110	8.34%	99.90%	2.67
6	104120	505	2526	351	445	17.60%	4.38%	4536	87	4241	223	5	754	4246	11.47%	99.89%	2.58
7	104810	508	2680	379	549	20.47%	8.75%	9123	177	8535	449	9	1175	8544	15.08%	99.89%	2.54
8	105479	511	2809	402	655	23.32%	17.50%	18344	358	17178	904	19	1917	17197	18.68%	99.89%	2.52
9	106132	513	2918	421	763	26.15%	35.00%	36879	716	34572	1820	38	3299	34610	21.72%	99.89%	2.54
10	106772	516	3010	438	871	28.93%	70.00%	74131	1423	69581	3662	75	5955	69656	23.89%	99.89%	2.57
11	107402	519	3088	451	978	31.66%	70.00%	74497	1404	70019	3685	74	6066	70093	23.14%	99.89%	2.63
12	108024	522	3156	463	1083	34.33%	70.00%	74859	1378	70458	3708	73	6170	70531	22.34%	99.90%	2.69
13	108641	524	3214	473	1187	36.93%	70.00%	75218	1348	70899	3732	71	6266	70969	21.51%	99.90%	2.77
14	109255	527	3265	482	1288	39.45%	70.00%	75576	1315	71340	3755	69	6357	71409	20.68%	99.90%	2.86
15	109865	530	3310	490	1387	41.90%	70.00%	75935	1279	71781	3778	67	6444	71849	19.85%	99.91%	2.95

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COST BENEFIT ANALYSIS

Presently, the massive growth in cost of healthcare can be traced to a number of issues that have influenced the way screening and diagnostic medicine is pursued.

One of these is the rise in the costs incurred by screening for clinically occult disease. These costs include increased monetary outlay due to over utilization and decreased patient safety due to averse effects of the diagnostic process combined with overtreatment.

What is not shown in this poster is the effect of drift in diagnostic criteria that tend to cause a rise in false positive diagnoses due to feed back of societal and medicolegal pressures to avoid missing a diagnosis.

EXAMPLE

There has been a significant rise in the diagnosis of thyroid, breast, and prostate cancer without a significant rise in mortality.

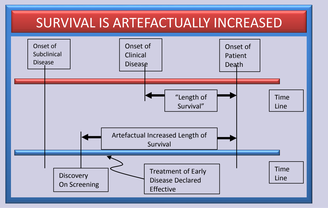
In this poster the effect of increased screening and increased sensitivity due to increased numbers of prostate core biopsies taken are illustrated. For any methodology this reduces specificity increasing false positives.

It should be noted that part of the rise in diagnoses is due to rising median age of the baby boomer population while the drop of mortality back to the baseline may be due to new therapies that affect advanced stage disease.

However, the model clearly shows test characteristics and utilization patterns influence apparent disease prevalence and, so, perceived screening/diagnostic power of a test. In addition, screening leads to:

➡ Earlier identification of True Positives artificially extending survival
➡ Earlier treatment of True Positives possibly actually extending survival

These two facts confound epidemiologic data used to make clinical and policy decisions.



CONCLUSION

The complex interaction of various clinical and societal factors greatly influences the rate of diagnostic error and so, epidemiologic error.

As the test utilization and/or test sensitivity rises the specificity of a test falls increasing the number of false positives leading to an asymptotic [not asymptomatic!] rise in apparent prevalence.

This resulting rise in prevalence, due predominantly to rising false positives, increases apparent positive predictive value of the test further overstating the power of the test in question leading to increased:

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