# USE OF INTEGRATED MEDICAL ANALYTICS TO CHARACTERIZE AND QUANTIFY THE COSTS OF UNNECESSARY THYROID FUNCTION TESTING

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***"The vast majority of healthcare organizations are data rich and information poor." [1]***

## ABSTRACT

The rate of growth in health care expenses experienced over the past several decades cannot be sustained economically in the long term [2]. Analyses of published studies from a large systematic review of the medical literature demonstrated that almost 19% of all clinical laboratory tests were unnecessary [3]. Integrated analytics using medical, operational, and financial data permits identification and quantification of unnecessary medical laboratory testing patterns. We queried multiple large medical data sets combined with operational data and detailed cost information to examine several specific patterns of unnecessary test utilization by health care providers. Medical evidence supports ordering a thyroid stimulating hormone (TSH) test alone as the first test in evaluating thyroid disease followed by other thyroid tests (free thyroxine [FT4] or free triiodothyronine [FT3]) if the original TSH test result is abnormal. However, the TSH test is frequently ordered concurrently with an order for a FT4 and/or FT3 test. There is considerable variation in ordering patterns between health care providers (e.g., at one large hospital system 9% of providers always ordered a TSH and FT4 together, while 46% never ordered the two tests together) as well as notable geographic and provider specialty differences. At one large hospital system, the additional annual cost of concurrently ordering two or more tests is $24,304; the additional cost at a larger regional hospital system is $200,208 (variable materials plus direct labor costs). We calculate the cost of additional testing to a large US health care insurance payer to be between $1.85 million and $1.91 million per year. Based upon our findings we issued an evidence-based coverage policy recommendation for thyroid function testing for health plan clients to reduce unnecessary laboratory test utilization.

## INTRODUCTION

Health care spending in the United States has increased by almost 100 fold over the last half century. Health care spending was $27.5 billion in 1960 and $2,593.5 billion in 2010. Health care expenses now represent 17.9% of gross domestic product compared with 5.2% fifty years earlier. Just over the decade from 2000 through 2010, health care costs have almost doubled and have come to comprise an additional 4% of the US economy [4]. Both government and private sector experts concede that the rate of growth in health care expenses experienced over the past several decades cannot be sustained economically in the long term [2]. For example, at recent annual rates of growth in health care costs and gross domestic product one could project that health care would account for 100% of the US economy sometime around the year 2100 (projection based on data published by CMS) [4].

Annual expenditures for clinical laboratory testing in the United States are approximately $69.5 billion (projected for 2012) [5]. Clinical laboratory testing represents approximately 2.4% of all health care expenditures (calculated) [4][6]. Perhaps of even greater importance, the results of clinical laboratory testing contribute significantly to medical decision making. Therefore, clinical laboratory results also drive downstream costs of follow-up diagnostic and prognostic testing as well as medications and other therapeutic interventions [7][8]. In recent years there has been a significant increase in labor productivity in the clinical laboratory. Nevertheless the cost of laboratory testing has continued to increase due to rising unit costs for reagents, materials, and labor [9]. The overutilization of diagnostic tests, however, is the more important driver of higher costs [10].

Notwithstanding the informational value of laboratory testing, many pathologists and other physicians have suspected for quite some time that a significant number of laboratory tests contribute very little, if any, value to patient diagnosis or therapy. Patient-weighted analyses of published studies from one large systematic review of the medical literature (>40 studies meeting inclusion criteria) demonstrated conservatively that almost 19% of all tests were unnecessary based on explicit *a priori* criteria. Using implicit criteria (e.g., group of cardiologists determining the need for cardiac marker testing based on information available to the ordering

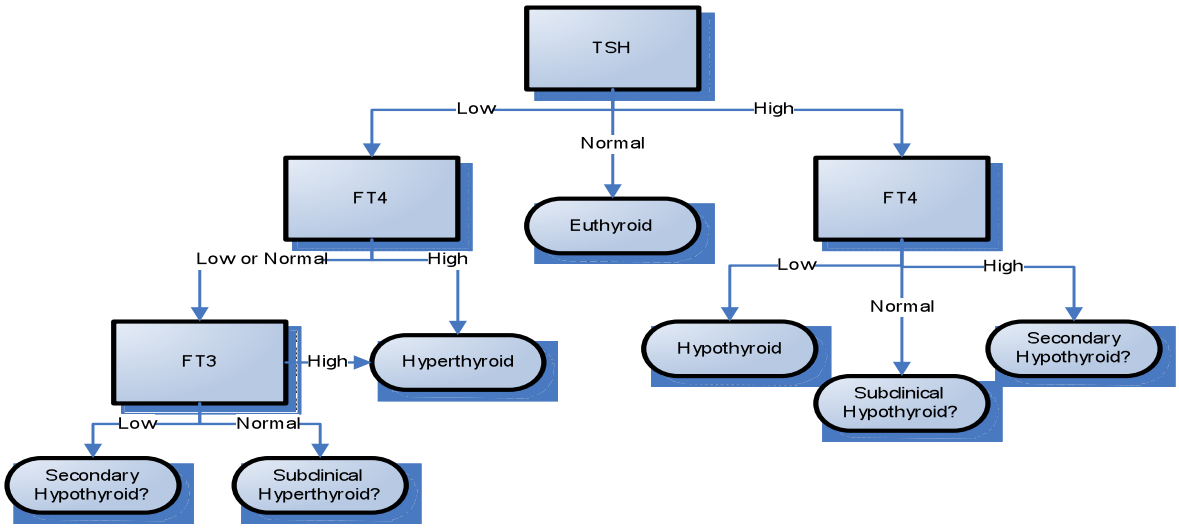
physician at the time the test was ordered) the percentage of unnecessary tests jumped to 58% [3].

Addressing the causes of laboratory test overutilization is complicated by two factors. First, there are thousands of tests, test combinations, and clinical scenarios in which tests may be ordered. For example, a typical large hospital laboratory offers between 500 and 1,000 different tests. Regional and national reference laboratories usually have a larger test menu of more than 1,500 tests. The number of relevant test combinations would be even larger. Furthermore, since the same tests are often ordered to address different diagnostic questions depending on the clinical scenario, the number of clinical scenario-test combinations would also be very large. Second, most health care institutions do not have adequate cost accounting systems to determine the financial impact of overutilization. Accurate cost accounting, such as activity-based cost accounting, is necessary to carry out medical cost-effectiveness analyses (CEA) allowing decision makers to optimize patient outcomes at the lowest cost [11]. Unfortunately, most US health care systems still do not fully employ the best cost accounting methods. For example, a 2005 survey of health care chief financial officers found that 52% of respondents reported using any cost accounting system; furthermore, while 71.8% of hospital financial executives were aware of activity-based cost accounting, only 4.7% reported its implementation in their health care system [12].

There are many different clinical testing scenarios that one might evaluate to optimize potential cost effectiveness. An analysis of thyroid function testing would be particularly useful because, 1) it is one of the more common testing scenarios encountered in the clinical laboratory, and 2) functional diagnoses are essentially defined by the test results [13][14]. Medical evidence supports ordering a thyroid stimulating hormone (TSH) test alone as the first test in evaluating thyroid disease followed by other thyroid tests (free thyroxine [FT4] or free triiodothyronine [FT3]) if the original TSH test result is abnormal (Figure 1) [15][16][17][18]. Nevertheless, the TSH test is frequently ordered concurrently with an order for a FT4 and/or FT3 test. Medical data mining combined with granular cost accounting data would identify testing patterns and quantify the cost of unnecessary thyroid function testing. Such integrated

medical analytics (IMA) would be important for health care decision makers to prioritize and address problems of unnecessary test utilization.

**FIGURE 1: Proposed thyroid function testing algorithm**.




## METHODS

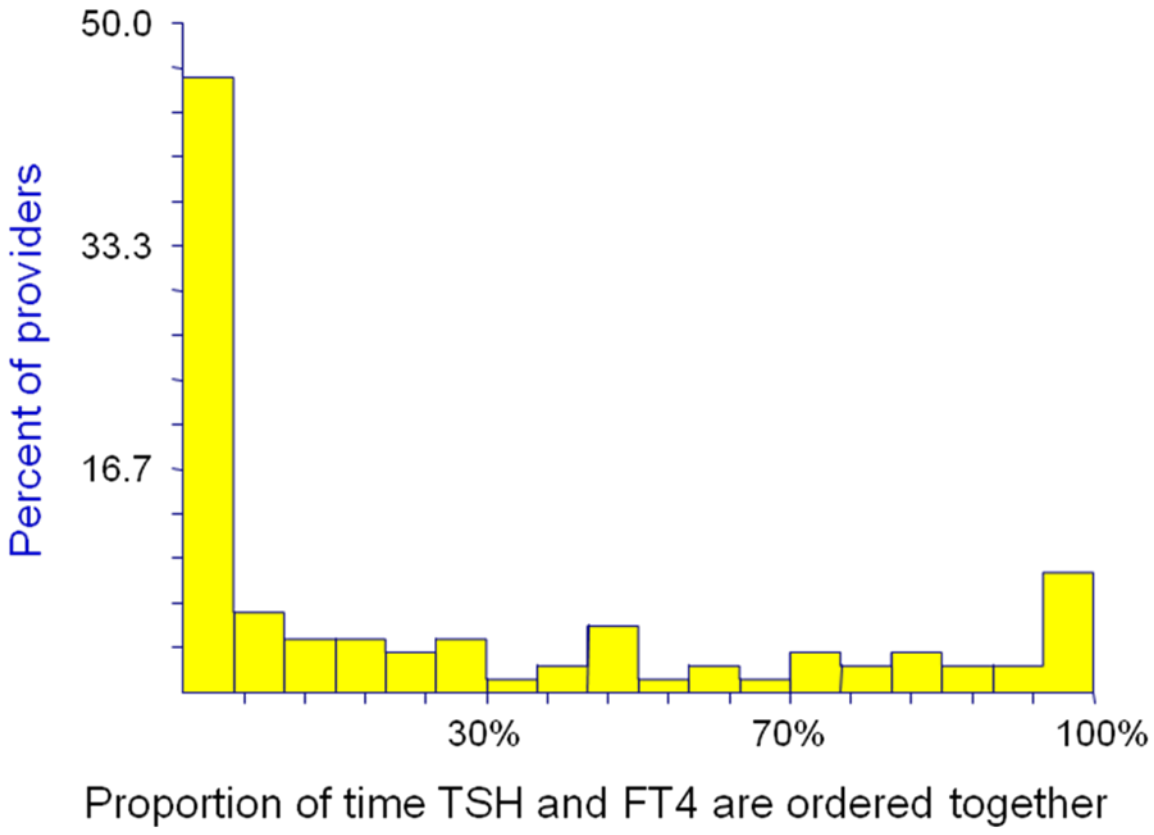
We queried relational data marts that include medical, operational, and cost information from hospital systems in Mississippi and New Mexico. To supplement query findings, we also obtained aggregate utilization parameters obtained using similar queries from a hospital system in Utah. Finally, we also queried the claims and billing database of a large private national health care insurer.

We first determined the number of FT4 tests carried out when the TSH test result was normal (within the established reference range). We stratified query results by ordering health care provider as well as provider medical specialty. We calculated variable throughput (reagents, controls, calibrators) cost, labor cost, as well as allocated overhead costs for FT4 testing at each hospital system. Claims payments for TSH and FT4/ FT3 were obtained from the large private insurer database.

## RESULTS

There was considerable variation in ordering patterns among individual health care providers. For example, in one large health care network 9% of providers always ordered TSH and FT4 tests on the same patient sample, while 46% never ordered the two tests together (Figure 2). There was considerable variability among physicians with different specialty training. For example, endocrinologists in one hospital system ordered the two tests together 34% of the time while pediatricians submitted concurrent orders 80% of the time (Table 1). In a different hospital system, the percentage of concurrent orders ranged from 1% (emergency medicine) to 61% (endocrinology).

**FIGURE 2. Breakdown by Provider Ordering Patterns**. Proportion of all requisitions for TSH with concurrent order for free T4 by individual provider. Percent of all individual providers never ordering the two tests together (leftmost bar, 46% of providers), always ordering the two tests together (rightmost bar, 9% of providers), or some proportion in between (45% of providers).



In addition, there is variability between providers of the same specialty working in different health care systems that are geographically separated. The greatest specialty differences between providers in two geographically-separated multi-hospital systems were family medicine (45% vs. 18%), emergency medicine (50% vs. 1%), and endocrinology (34% vs. 61%). It is worth noting that system 2 has an option for the provider to order a TSH with reflex FT4 (FT4 only if the TSH is abnormal). Consequently, the lower percentage of concurrent test ordering for hospital system 2 likely reflects this additional option that is unavailable in system 1.

**TABLE 1. Proportion of TSH and free T4 concurrent orders for two multi-hospital systems stratified by provider specialty.**

| Specialty (Type of Practitioner) | System 1* | System 2* |
|---|---|---|
| Family Practice | 45% | 18% |
| General Internal Medicine | 37% | 16% |
| Emergency Medicine | 50% | 1% |
| Physician Assistant | N/A | 26% |
| OB/GYN | 56% | 21% |
| Endocrinology | 34% | 61% |
| Nurse Midwife | 64% | N/A |
| Family Medicine Nurse Practitioner | N/A | 26% |
| Pediatrics | 80% | N/A |
| Other | 48% | 28% |
| Unknown | 37% | 29% |

** Each hospital system has > 10 hospitals (ranging from 35 beds to > 500 beds) and multiple clinics. The systems are located in different US states*

At one large hospital system, the additional total annual cost for unnecessary FT4 testing was $37,391; the additional total annual cost at a larger regional hospital system was $293,650. When limited to variable and technical labor costs, annual savings are $24,304 and $200,208, respectively. The latter figures are probably more representative of cost savings that could be realized in the short term given the propensity of fixed overhead costs to remain unchanged with small changes in total test volume. At the individual health care provider level, annual costs (throughput plus technical labor cost) for unnecessary FT4 testing among the 20 highest cost providers in one hospital system ranged from $1,451 to $4,160 (Table 2). These additional costs are largely borne as claims payments by health care insurers (government and private).

Using the percentage of all TSH test results that are abnormal at two hospital systems we calculated payments to cover unnecessary FT4 testing for a large US health care insurance company to be between $1.85 million and $1.91 million per year.

**TABLE 2. Cost breakdown of thyroid function testing for the 20 highest cost providers.**

| Provider | TSH[1] | FT4\|nl TSH[2] | Pct | Throughput[3] | Vbl + Labor[4] | Total cost[5] |
|---|---|---|---|---|---|---|
| A | 2,416 | 1,594 | 65.98% | $3,323 | $4,160 | $6,102 |
| B | 1,708 | 1,300 | 76.11% | $2,711 | $3,393 | $4,977 |
| C | 1,918 | 1,260 | 65.69% | $2,627 | $3,289 | $4,823 |
| D | 1,352 | 1,138 | 84.17% | $2,373 | $2,970 | $4,356 |
| E | 6,024 | 1,126 | 18.69% | $2,348 | $2,939 | $4,310 |
| F | 1,284 | 1,030 | 80.22% | $2,148 | $2,688 | $3,943 |
| G | 1,758 | 998 | 56.77% | $2,081 | $2,605 | $3,820 |
| H | 1,304 | 846 | 64.88% | $1,764 | $2,208 | $3,239 |
| I | 1,232 | 798 | 64.77% | $1,664 | $2,083 | $3,055 |
| J | 878 | 760 | 86.56% | $1,585 | $1,984 | $2,909 |
| K | 818 | 734 | 89.73% | $1,530 | $1,916 | $2,810 |
| L | 866 | 686 | 79.21% | $1,430 | $1,790 | $2,626 |
| M | 796 | 676 | 84.92% | $1,409 | $1,764 | $2,588 |
| N | 772 | 664 | 86.01% | $1,384 | $1,733 | $2,542 |
| O | 872 | 656 | 75.23% | $1,368 | $1,712 | $2,511 |
| P | 732 | 612 | 83.61% | $1,276 | $1,597 | $2,343 |
| Q | 792 | 610 | 77.02% | $1,272 | $1,592 | $2,335 |
| R | 708 | 592 | 83.62% | $1,234 | $1,545 | $2,266 |
| S | 724 | 560 | 77.35% | $1,168 | $1,462 | $2,144 |
| T | 640 | 556 | 86.88% | $1,159 | $1,451 | $2,128 |
| … | … | … | … | … | … | … |
| **All Providers** | **228,818** | **76,708** | **33.52%** | **$159,936** | **$200,208** | **$293,650** |

[1]*Total TSH orders*
[2]*FT4 ordered given that the TSH test result was normal (i.e., within the reference range)*
[3]*Throughput costs (variable materials, controls, calibrators)*
[4]*Variable throughput costs plus labor costs*
[5]*Total costs including overhead costs*

## DISCUSSION

The cost of unnecessary testing is substantial to the U.S. health care system. Integrated analytics using medical, operational, and financial data permits identification and quantification of unnecessary medical laboratory testing patterns. Knowledge obtained through integrated medical analyses allows providers, hospitals, clinics, and payers to focus on strategies to reduce unnecessary resource utilization and quantify the cost effectiveness of diagnostic testing [19].

Within the narrow confines of thyroid function testing, we identified considerable variability in test ordering patterns among health care providers, provider specialties, and geographically-separated health care systems. Another European study also found significant differences in laboratory test utilization between hospitals [20]. While other studies have estimated the extent of unnecessary testing, none have calculated detailed cost information and used specific laboratory test results to accurately estimate costs of specific testing patterns [2]. Additional costs from unnecessary thyroid function tests can be substantial within a hospital system; in fact, test ordering patterns of individual providers can add well over $1,000 per year in unnecessary thyroid testing costs (excluding fixed overhead costs). Naturally, as other tests and clinical scenarios are evaluated the potential cost savings are likely to be much higher.

A recent survey of 95 providers asked their motivation to promote business intelligence (BI) initiatives within their organization; 80% of respondents said BI was needed to manage rising costs and 46% said it was needed to improve medical outcomes [1]. Integrated medical analytics includes and builds upon customary BI activities through joining more traditional financial, operational, and marketing data with diagnostic, prognostic, and therapeutic data.

Identification of some unnecessary utilization patterns has already led to efforts to reduce costs [21][22][23]. Based upon our findings we drafted and issued an evidence-based coverage policy recommendation for thyroid function testing to health plan clients to reduce unnecessary laboratory test utilization [24].

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