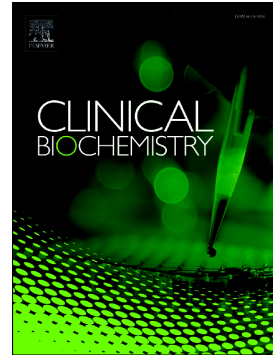


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Clustered interventions to reduce inappropriate duplicate laboratory tests in an Irish tertiary hospital.

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Abstract

Background

There is increasing emphasis on understanding the rate, and avoidable costs, of inappropriate laboratory testing in hospitals, especially associated with duplication of tests following transfer of patients from one hospital to another. While studies of inappropriate testing have been reported previously, there are no published data relevant to Ireland.

Aims

To determine the baseline rate of inappropriate testing for a subset of clinical parameters, specifically, full blood counts (FBC), biochemistry profiles (Bio) and coagulation (Coag) screens for geriatric patients transferring to and from University Hospital Limerick (UHL). Prospective pilot-scale implementation of five clustered interventions, and assessment of their effect.

Methods

Baseline testing levels were determined between October 2013 and January 2014. A patient survey was conducted to evaluate patient awareness of the blood tests they underwent. Five interventions were trialled sequentially each month between January and May 2014. These included: educational poster, intern training, presentations and communication to consultants; automated prompt in the Lab Information Technology system; highlighting of patient survey results to medical staff; inclusion of laboratory test details on patient transfer document; patient booklet promoting empowerment. Impact was assessed by determining rates of inappropriate laboratory testing monthly, and associated actual cost reductions were calculated.

Results

Approximately two-thirds of geriatric inpatients were unaware of why they underwent blood tests. Baseline numbers of inappropriate duplicate FBCs, Bio profiles and Coag tests were 758, 749 and 268 respectively for patients transferring to and from UHL. Following the interventions, these numbers dropped to 85, 84 and 0, respectively.

Conclusion

The interventions resulted in sustained reduction in rates of inappropriate testing by May 2014. Extrapolated cost reductions exceed two million Euro annually. The most effective intervention involved staff education.

Keywords: Inappropriate laboratory testing; laboratory test utilization; test ordering practices; cost reduction; tertiary hospital

Introduction

The Irish Government has implemented a funding model for hospitals known defined as Activity-Based Funding (ABF), formerly “Money Follows the Patient”, representing a considerable modification of the mechanism by which hospitals are funded [1, 2]. In January 2014, this policy came into force for 38 of the state’s largest public hospitals’ inpatient and day case activity. The policy replaces the previous arrangement of block grant allocation and, as elsewhere [3], places an emphasis on specific episodes of care, adjusted as appropriate for complexity of cases. Two specific outcomes of this model of funding are an increased vigilance regarding “cost per case” and a keen focus on the economic evaluation of procedure and processes. Such focus, however, is not specific to Ireland and has been described in reports from other countries where this model has been adopted, e.g., with reference to Medicare in the USA and the UK’s National Health Service (NHS) [4, 5].

In the context of economic scrutiny, therefore, it is not surprising that clinical laboratory testing, as the highest volume medical activity in hospitals [6], has become a focus of cost-reducing initiatives. Performing a thorough history and physical examination are necessary to formulate possible differential diagnoses. Furthermore, at least 10% of diagnoses are not considered final until clinical laboratory testing is complete [7-9]. That said, however, laboratory test overutilization has been the focus of multiple studies internationally as they can increase costs, lead to unnecessary investigations, and may have a negative impact on patient outcomes [10, 11].

Such international studies include recent publications that have highlighted the challenges associated with laboratory overutilization or inappropriate laboratory testing. Specifically, in 2017, Chemi et al [12] reported rates of inappropriate laboratory investigations of up to 20% between 2006-2010 in Ontario, defined as testing >2 weeks prior to the minimum threshold to reorder defined by practice guidelines, and noted that up to 85% of the time the ordering physician of an inappropriate test was the same physician who ordered the previous appropriate test. Further data from 103,000 Canadian patients, provided by Morgan & Naugler (2015) [13], showed an inappropriate testing rate of 16% in Calgary, while in 2016, Meidani et al [14] detailed incidence of 26.4% in Iran. The most comprehensive study of the subject, compiled by Zhi et al in 2013 [15] from a 15 year meta-analysis of international literature demonstrated laboratory over- and underutilization rates of 20.6% (95% CI 16.2-24.9%) and 44.8% (95% CI 33.8-55.8%), respectively, with the latter being greatly more under-studied.

In light of these relatively high rates of lab over-use, it is perhaps unsurprising that the excellent review by Kobewka et al in 2015 [16] evaluated 109 eligible papers, published between 1946 and 2013, detailing interventions for reduction of unnecessary tests. Although of varying quality, these interventions were identified as belonging to one or more non-exclusive category of education, audit and feedback, system based, or incentive or penalty. Results ranged from a 99.7% reduction to a 27.7% increase in test use. The authors noted that numerous studies use low investment strategies to reduce test utilization and recommended that it was these low investment strategies that may be the most promising for achievable and durable reductions in inappropriate test use.

Malone (2013) [17] described interventions that asked physicians not to order blood counts and metabolic panels if they did not have a specific indication in mind. Varying complementary reinforcements were employed: posters displayed in the Intensive Care Unit listing acceptable indications for FBCs and electrolyte tests; doctors were educated; prompts were added to order

systems for lab tests reading, e.g., “*please do not order without an indication*”. The approaches were rewarded with reductions overall of up to 24%, with patient safety and quality of care unaffected adversely.

Based on anecdotal evidence of lab test over-utilization of lab tests, similar to that discussed by Stewart et al (2010) [18] whereby 32% of medical inpatients transferring between hospitals were subjected to inappropriate duplicate testing, the objective of our quality improvement project was to assess and to attempt reduction of inappropriate duplicate laboratory testing of acutely unwell geriatric medical patients transferred to and from University Hospital Limerick (UHL). Wishing to utilize low investment tactics, we choose to assess the impact of a series of interventions modeled on the Malone’s previously described successful approach.

Methods

Setting and Patients

The University Hospital Limerick Group consists of the University Hospital Limerick (UHL); Ennis General Hospital; Nenagh General Hospital; St John's Hospital Limerick; the University Hospital Maternity Hospital and Croom Hospital. UHL provides 24/7 acute surgery, acute medicine, and critical care, as well as tertiary care. The other five hospitals provide the majority of hospital activity including extended day surgery, selected acute medicine, local injuries and a range of diagnostic services. The hospital group serves a population of circa 400,000 people.

Patients transferring between UHL and three of the University Limerick Group hospitals, namely Nenagh General Hospital, Ennis General Hospital and St John's Hospital admitted under the Geriatric Teams as part of the General Medical Take were included.

Ethical approval

Ethical approval to complete this study was granted by the Health Service Executive (HSE) University of Limerick Hospitals Group Research Committee.

Laboratory testing

The focus was on potential duplicate lab tests occurring in patients transferring within UHL Group on day of transfer, specifically full blood count (FBC) (also referred to as a complete blood count – CBC), biochemistry profile (Bio) and Coagulation tests (Coag). Thyroid function tests (TFTs), hematinic (B12, ferritin, folate) and serum protein electrophoresis (SPEP) were also evaluated. SPEP may include immunoglobulin A, G and M (IgA, IgG and IgM) tests. Laboratory managers and the hospital group finance department provided laboratory costs. In the absence of interventions (e.g., blood transfusions), tests were considered inappropriate duplication according to the following criteria: TFTs – repetition within a four week period based on recommendations in “The UK Guidelines for the Use of Thyroid Function Tests” produced by the Association of Clinical Biochemistry and the British Thyroid Association and the British Thyroid Foundation (2006); hematinic - repetition within an eight-week period based on a study published in the International Journal of Laboratory Hematology (2011); SPEP - repetition within an eight week period; immunoglobulins - repetition within eight weeks.

Determining baseline levels of laboratory testing was performed between October 2013 and January 2014. Specifically, patients transferred to and from UHL under the care of the Geriatric consultants on General Medical Take were identified by Bed Management in the hospitals. Each patient's name, date of birth, medical record number (MRN) and the date of transfer were recorded. The time between testing and admitting or discharge diagnosis were documented and the following data were then collected for each patient: transferring and accepting consultants; diagnosis; FBCs; Bio profiles and Coag screens done (on the day of transfer in the transferring hospital and in accepting hospital); TFTs; hematinic and SPEP tests done in the transferring and accepting hospitals; and the duration of time between repeat tests. All of the listed laboratory results were reviewed by a clinician to determine if inappropriate duplicate testing was evident.

Interventions

Prior to initiation of the interventions, in January 2014, a qualitative patient survey was designed, validated by pilot trialing using clinical staff, and conducted in conjunction with the Patient Advocacy Service to gauge patients' experience of blood testing in UHL and their awareness of the purpose

for those tests. The survey was conducted face to face and involved a semi-structured interview of 20 consecutive patients encountered on transfer to UHL.

The interventions were introduced sequentially, monthly from January to May 2014 (Figure 1). Laboratory testing was analyzed retrospectively monthly to determine the effect of each intervention.

Intervention 1: Poster/educational intervention - Posters regarding inappropriate re-testing of FBC, Bio profile and Coag were displayed prominently in the Emergency Departments of University Hospital Limerick Group. We were unable to gauge what proportion of ordering clinicians saw the posters. However, flyers regarding inappropriate re-testing of TFTs, hematinic, SPEP and immunoglobulins were placed in the phlebotomy folders, which are available in all clinical areas.

Intervention 2: Presentation/educational intervention - A Grand Rounds presentation to highlight the issue of inappropriate duplicate testing was given, targeting medical consultants, registrars and senior house officers. Grand Rounds are open to all clinicians within the University Hospital Limerick Group and are provided at the main University Hospital site. We were unable to estimate the percent attendance versus ordering clinicians. However, additional presentations were made at Medical Intern Training to highlight the issue and communication was sent electronically to the Medical Team members official email addresses to alert for inappropriate duplicate testing.

Intervention 3: Lab Information Technology system review – Laboratory staff introduced a prompt in the Lab IT system for minimum recommended intervals for repeat testing. This occurred on request of an order for a test that had been requested previously (if within the repeat period). Staff then decided whether or not to proceed with the test. The requesting clinician had to be informed if the test was not performed. Where the clinician believed there was a compelling reason to do so, they could overrule the laboratory staff and the test could be performed.

Intervention 4: Patient empowerment – The patient survey results were reviewed and a poster to inform all doctors and phlebotomy staff of the key results was displayed prominently. In addition, a HSE-produced leaflet was adapted to include a section describing common blood tests and made available to inpatients.

Intervention 5: Modification of the transfer letter - Discharge/Transfer/Referral Communication documentation and ISBAR patient transfer communication tool was reviewed and adjusted to include a section on lab tests performed during the inpatient stay and on the day of transfer. ISBAR is a HSE-recommended tool to remind staff how to communicate effectively, what key questions to ask, and what information to provide in clinical situations, such as transferring of patients. The ISBAR tool originated from the US Navy and was adapted for use in healthcare by Dr M Leonard and colleagues from Kaiser Permanente, Colorado, USA.

Results

Patient survey

Twenty patients were surveyed as that was the number of patients (in the care of the geriatric department) transferred on a single random day who experienced interaction with the phlebotomy service. The survey was anonymized and their age, gender, and reason for hospitalization was not recorded. Each of the participating patients recalled having blood samples taken, with 18 of the 20 remembering whether a doctor (9/18) or phlebotomist had performed the venipuncture. Only 7/18 patients understood why their blood was collected with two of those having asked the question of the phlebotomist. Common comments made by the remaining patients were similar to “assumed it was procedure” and; “they wouldn’t have taken it if they didn’t want it.” Seven patients mentioned having multiple samples drawn on a single day, while four patients recognized that they had samples collected on multiple times on a single day for the same test. It is especially noteworthy that 11/20 patients were comfortable that staff explained to them, at least to some degree, why they were performing procedures on them including venipuncture and that, generally, the explanations were understandable. Eight patients believed that not enough information had been provided to them, with one stating that “staff are not concerned about questions”.

Review of baseline levels of inappropriate laboratory testing

Between October 2013 and January 2014, a review of the two lab information systems used within the UHL group (Agilent’s iLab and Custom Software’s NetAcquire) determined an almost perfect correlation between performance of FBC and Bio profile screens, suggesting that they were almost always ordered together. During the initial review period, between 60 – 85% of patients transferred to UHL underwent FBC and Bio tests, with between 40 – 63% undergoing Coag screens. Of patients transferred from UHL, approximately 70% consistently underwent FBC and Bio tests, with <40% undergoing Coag screens. During the baseline review period, up to 80% of patients who transferred to UHL and had FBCs and Bio profile screening performed were subject to inappropriate duplicates (Figure 2a). Inappropriate Coag testing peaked at less than 65%. In both cases, the maximum rate of lab over-utilization occurred in December, correlating with recognized peaks in geriatric medical cases in the winter months. In contrast, when patients transferred from UHL to the other group hospitals, the levels of inappropriate FBC, Bio and Coag testing never exceeded 50% of that seen when the patient journey was reversed. Peak numbers were again in December (Figure 2b).

Inappropriate duplication of TFT and hematinic tests were seen on transfer from UHL (maximum 25% and 40%, respectively) and on transfer to UHL (50% and 40%, respectively). However, there was no inappropriate SPEP testing identified at any point in this study.

In summary, 720 patients transferred to UHL resulting in 1035 unnecessary tests, while 1929 patients transferred from UHL resulting in 1400 unnecessary tests. A breakdown of these numbers across the testing criteria is provided in Table 1.

In reviewing the patient records, other notable features of the systems were identified: the lack of a single shared IT system across the hospital group meant that attending physicians and laboratory staff were unable to access all patient records; patients did not have a single consistent MRN and each hospital issued a new MRN on admission; transferred patients were not accompanied by their blood test results and transfer letters did not consistently refer to tests or provide results of same; as the lab test ordering system was paper-based, duplicate tests for patients were not “flagged”.

Post-intervention levels of inappropriate laboratory testing

Overall, implementation of the series of interventions was successful. The levels of inappropriate FBC, Bio and Coag tests performed on patients transferring to UHL decreased from a maximum of 80% to 14%, 80% to 14%, and 65% to 0%, respectively between January and May 2014 representing a total of 170 tests (Figure 2a). Similarly, the levels of inappropriate FBC and Bio tests performed on patients transferring from UHL decreased from a maximum of 38% to 0%, while inappropriate Coag tests reduced from 22% to zero representing a total of 169 tests (Figure 2b).

Over the course of the interventions, inappropriate TFT and Hematinic testing of patients transferring to UHL decreased from 57% to zero and 40% to zero, respectively. For patients transferring to UHL, the observed reductions were 25% to 8% and 20% to 11%, respectively. In all cases, these reductions have been maintained since May 2014.

In assessing the impact of each individual intervention, it was notable that following each there was a decrease in inappropriate testing with the exception of Intervention 2, after which patients transferred from UHL underwent increased Coag tests. This has not been correlated with any specific microbiology outbreak or other cause, and was transient. In obtaining feedback from participating clinicians, the intervention most commonly referred to was Intervention 2. However, this was also the Intervention that was referred to as having most limitations, namely: not all targeted clinicians may have attended the intern training presentations or Grand Rounds; not all staff clinicians routinely use their hospital email addresses and, therefore, may not have read the emails regarding inappropriate testing; it is impossible to know how many clinicians saw and/or acted on the information displayed on the posters.

Similarly, following Intervention 4, patients transferred to UHL underwent increased Bio profiles, albeit that the increased number did not reach pre-intervention numbers from January. Again the increased testing was transient.

Determining cost reductions.

Over the course of these interventions, relating only to the cohort of geriatric patients transferred to and from UHL, the total number of inappropriate tests avoided exceeded two thousand (Table 2). Coordination between the laboratory managers and the finance department calculated the savings at approximately €13,500. These costs were based on full economic costings incorporating time, equipment use, consumables and reagents.

To determine the potential influence of the interventions across all transferred patients being cared for by all clinical specialties, we utilized the full year laboratory testing costs provided by the finance division of the hospital group based on actual tests performed and associated expenditure (Table 3). While the savings related to this current study were modest, projecting similar success for a full year and across disciplines would have resulted in reductions of between 115,462 and almost 388,000 FBC, Bio, Coag, TFT and Hematinic tests. The associated savings were calculated as being between €717,848 and almost €2.9 million, based on 2013/2014 costs.

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Discussion

Laboratory tests appropriately play a role in modern medicine, and rapidly evolving molecular techniques expedite patient care and enhance outcomes [19 - 21]. However, there is acknowledgement of inappropriate, and over-utilization of, laboratory testing. In this context, a series of sequential interventions were implemented successfully in a mid-West of Ireland hospital group, resulting in reduction of unnecessary tests and generation of financial savings. Although performed in relation to a single medical discipline, geriatrics, and focusing on transfer patients only, extrapolation of the results across the scope of the hospital group activities projected multi-million Euro cost reductions.

Our study focused on transferred geriatric patients from January to May 2014, resulting in savings of approximately €13,500. However, while the observed effect was modest, extrapolation of the cost reductions projected that if the interventions could be translated into similar success across the range of clinical disciplines and laboratory testing, meaningful budgetary savings of between €717,848 and almost €2.9 million could be made. The potential consequence of the interventions, however, would be evident beyond financial planning as clinical workload, patient management, and laboratory resource utilisation would also benefit considerably.

Evaluating the series of interventions, and their separate relative contributions to the successful reductions seen, proved difficult due to considerable monthly variations (Figures 2a and 2b) in the patient cohort and complexity of their testing requirements. A limitation of this study, and a challenge in interpreting the impact of the interventions, is that determination of the individual success or failure of any intervention would require repetition of the exercise over a number of years, correcting for seasonality and patient demographics. That said, however, it appears evident that first two interventions, both educational in nature, caused initial decreases in unnecessary lab tests. As these interventions were not repeated in later months, and as the resulting decreases were sustained subsequently, it is reasonable to argue that the latter three interventions caused both confirmation in behavioral changes related to lab test requests and consolidated that modification.

These are reasonable arguments, as our experience closely mirrors beneficial outcomes of such low investment approaches described by Malone previously [17], specifically education- and awareness-based intervention. Such strategies may be attractive to hospitals attempting to achieve improvements without requirement for significant resource allocations. However, given the turnover of clinical staff (and patients) in most healthcare facilities, such interventions may require repetition and sustained focus for long-term success. For that reason, interventions to reduce inappropriate lab testing have tended to concentrate on test-ordering IT systems and / or associated patient-related documentation. Therefore, our intervention involved the inclusion of prompts in the ordering system to highlight recent tests and to query requirement for repetition. Prompted by the benefit seen in modifying the information technology, in 2015 an integrated patient management system was implemented facilitating a unique patient identifier MRN for each patient within the UHL hospital group and, thus, reducing a further identified barrier to efficient lab testing.

To our knowledge, this is the first report analyzing influence of such interventions in Ireland on both the actual burden of laboratory testing in addition to financial impact. However, this topic is of concern internationally with previous papers having described cost-saving exercises focused on reduction of laboratory tests in: South Africa [22], where a study of 320 patients over four weeks in identified €5,500 of avoidable test-related costs; in the USA, the “choose wisely” campaign [23]

demonstrated cost savings of \$290,000 over 2 years relating to Centers for Medicare and Medicaid Services; also in the USA, an intervention to reduce costs associated with duplication of B-Type Natriuretic Peptide tests delivered approximately \$92,000 per year [24]; while a 2016 Spanish report [25] described excessive requests for total bilirubin (tBil) testing and an intervention that netted \$9825.50 in savings over two years.

A reflection of the continuing international focus on laboratory cost reductions and appropriate resource utilization, and indeed an indication of the generalizability of our study, is the fact that during the time since our study was performed, interventions with analogous outcomes have been reported from the USA [23, 24, 26] and Italy [27, 28]. However, it is the Canadian intervention described by Gottheil et al in 2016 [29] that perhaps most closely resembles our work in combining educational activities and complementary modifications to the IT system that successfully generated a reduction of 40% reduction on lab over-utilization, results that are comparable with our outcomes. We would, therefore, suggest that future interventions involve combination of repeated and consistent raising of awareness among those responsible for ordering tests, patients undergoing tests and their families, complemented by provision of prompts integrated within the IT system.

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Author contributions: All authors contributed to the following. (1) The conception and design of the study, or acquisition of data, or analysis and interpretation of data, (2) drafting the article and revising it critically for important intellectual content, and (3) final approval of the submitted version.

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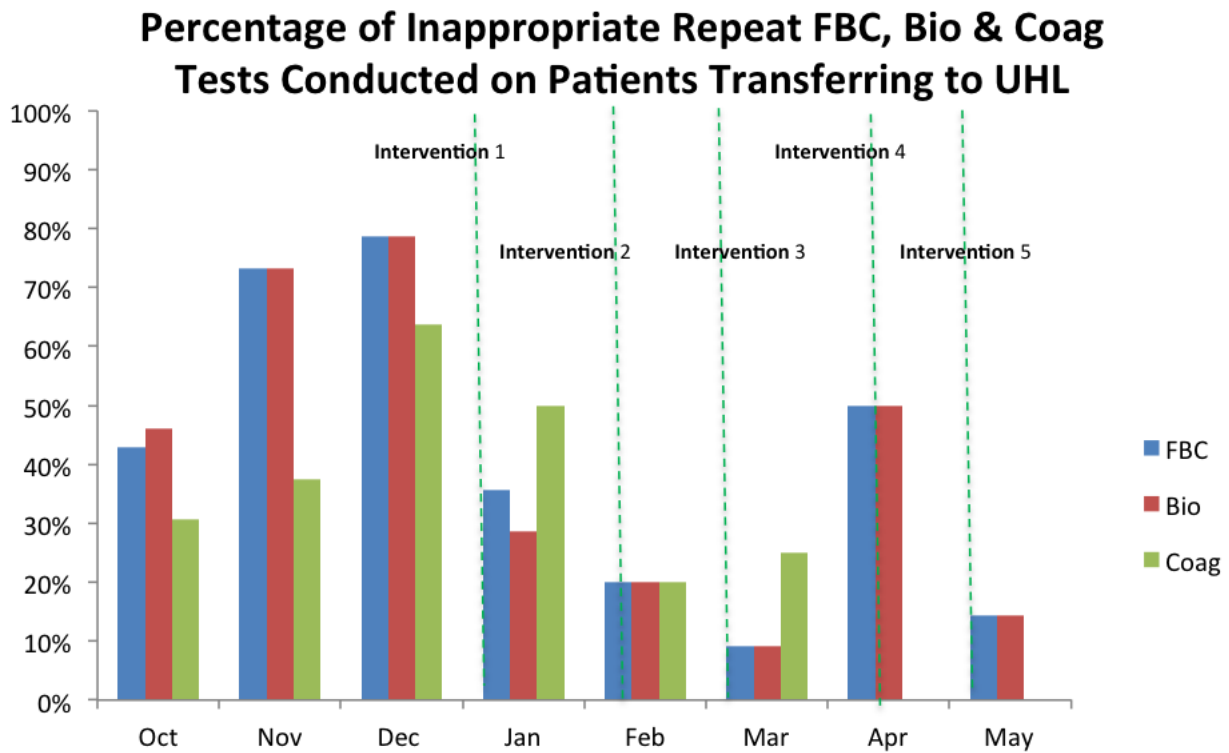
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Tables and Figures

Figure 1. Design and timing of the quality improvement interventions.



Figure 2a. Inappropriate testing of patients transferred to University Hospital Limerick (UHL) from other group hospitals (JENS)



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Figure 2b. Inappropriate testing of patients transferred to other group hospitals (JENS) from University Hospital Limerick (UHL).

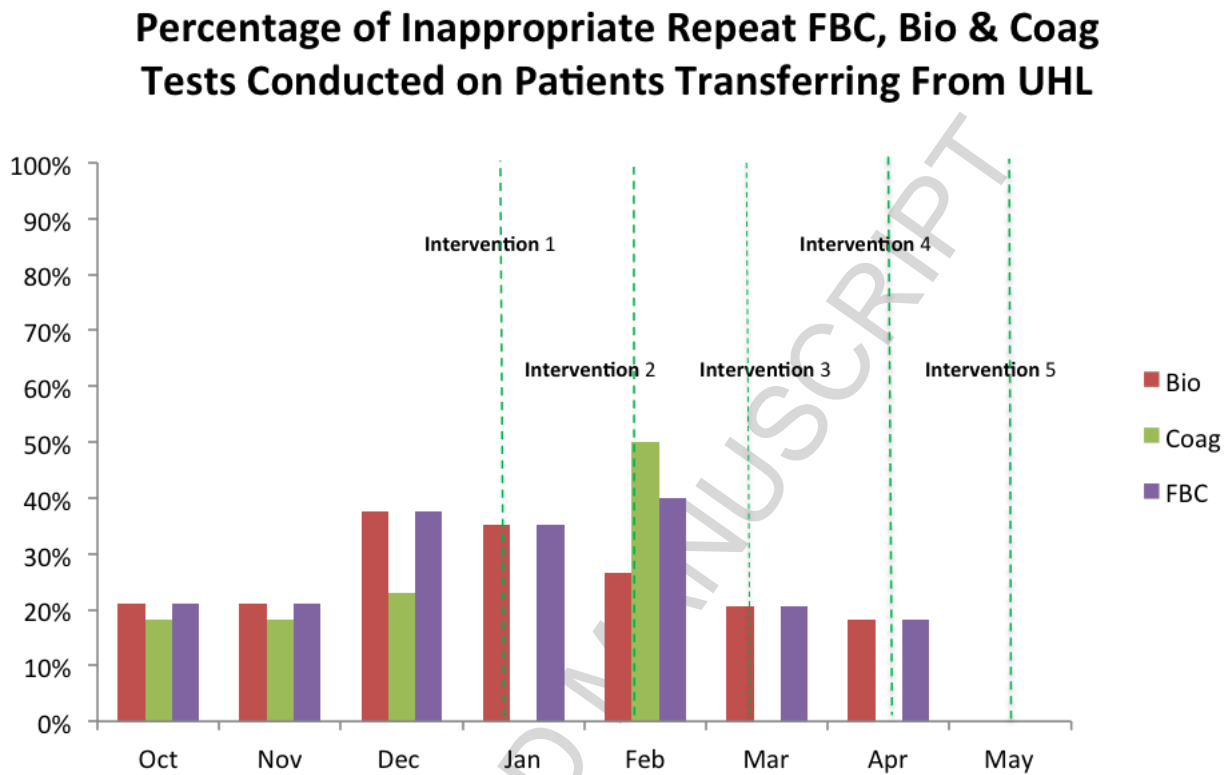


Table 1. Baseline number of patient transfers and associated laboratory testing

	FBC	Bio	Coag	TFT	Hematinic	SPEP	Total
No. of patients transferred to UHL 720							
% of patients tested - No. in ()	83% (598)	82% (594)	55% (396)	48% (349)	33% (239)	14% (98)	
% inappropriately tested	58%	57%	45%	35%	21%	0%	
No. of inappropriate duplicate tests	345	336	180	123	51	0	1035
No. of patients transferred from UHL 1929							
% of patients tested - No. in ()	75% (1439)	75% (1439)	30% (588)	58% (1119)	35% (683)	10% (199)	1400
% inappropriately tested	29%	29%	15%	25%	30%	0	
No. of inappropriate duplicate tests	413	413	88	284	202	0	
Total No. of inappropriate duplicate tests to/from UHL	758	749	268	407	253	0	2435

Table 2. Financial impact of interventions

Impact of Interventions	FBC	Bio	Coag	TFT	Hematinics	SPEP	Total
Reduction in inappropriate testing per year	673	665	268	313	177	-	2,096
Reduction in costs per year (€)	1,413	4,954	3,158	1,880	2,090	-	13,495

Table 3. Possible annual cost reductions (based on full year 2013)

Impact of Interventions	FBC	Bio	Coag	TFT	Hematinics	SPEP	TOTAL
Reduction in inappropriate testing per year	35,311-140,906	34,048-133,602	13,130-40,181	26,547-54,694	6,426-18,348	-	115,462-387,731
Reduction in costs per year (€)	74,153-295,902	253,657-1,576,504	154,930-474,132	159,282-328,164	75,826-216,506	-	717,848-2,891,208

ACCEPTED MANUSCRIPT

Clustered interventions to reduce inappropriate duplicate laboratory tests in an Irish tertiary hospital.

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Highlights:

- There is increasing emphasis on understanding the rate, and avoidable costs, of inappropriate laboratory testing in hospitals.
- There are no published data relevant to Ireland.
- Pilot-scale implementation of five clustered interventions, and assessment of their effect.
- Approximately two-thirds of inpatients were unaware of why they underwent blood tests.
- Baseline rates of inappropriate testing for FBCs, Bio profiles and Coag screens were 29%, 29% and 12%, respectively for patients transferring from large teaching hospital and 58%, 57% and 45%, respectively, for patients transferring from that hospital.
- The interventions resulted in sustained reduction in rates of inappropriate testing