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A Business Analytics Framework for Primary Care

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Abstract. In this paper, we present a Business Analytics (BA) framework, which addresses the challenge of analysing primary care outcomes for both patients and clinicians from multiple data sources in an accurate manner. A review of the process monitoring literature has been conducted in the context of healthcare management and decision making and its findings have informed the formulation of a BA conceptual framework for process monitoring and decision support in primary care. Furthermore, a real case study is conducted to demonstrate the application of the BA framework to implement a BA dashboard tool within one of the largest primary care providers in England. Findings: The main contributions of the presented work are the development of a conceptual BA framework and a BA dashboard tool to support management and decision making in primary care. This was evaluated through a case study of the implementation of the BA dashboard tool in London's largest primary care provider. This BA tool provides real-time information to enable simpler decision-making processes and to inform business transformation in a number of areas. The resulting increased efficiency has led to significant cost savings and improved delivery of patient care.

Keywords. primary care, business intelligence, healthcare management

1. Introduction

Healthcare in high income countries is going through a period of critical stress. Partly this is connected to the need to manage increasing costs: both in terms of per-capita cost due to the availability of innovative but expensive new technology (both machinery and drugs), and the increasing cost of expertise. But also, this is due to the well-known changes in demographics as life expectancy continues to increase. The significance of the latter is not just through the increase in the aged population and their associated healthcare needs, but perhaps more importantly from the perspective of this paper, their care may require qualitatively different management approaches due to the significant propensity towards the development of long-term conditions and of comorbidities. Furthermore, apart from increasing costs, challenges in healthcare include unacceptable error rates and dissatisfied patients and providers. In this paper, we will limit the discussion to primary healthcare, and present the challenges associated with data

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management for effective process monitoring and decision making, along with proposing a Business Analytics (BA) framework to address these needs in primary care.

2. A Business Analytics framework for primary care management

Primary care is riddled with huge variations in care quality, and both commissioners and providers are limited with regards to insight, oversight and assurance on quality and safety due to inadequate analytics capabilities and tools. Publication of the "NHS Long Term Plan", which was preceded by the "NHS 5 Year Forward View" and the "GP Forward View" reports, highlights the need for primary care to be equipped with intelligent decision-making tools, and the ability to work at-scale [1,2]. This is generating a need for a standardized decision-making Business Analytics (BA) framework, which addresses the challenge of analysing healthcare outcomes for both patients and clinicians from multiple data sources in a more accurate manner.

Based on the findings of the above analysis and literature review and aiming to provide a new approach to reliable, secure and affordable reporting in primary healthcare, a new conceptual Business Analytics framework for primary care management is proposed, comprising the following elements:

- *Comprehensive reporting and user-centred Views.* The new BA framework supports reporting on all clinical and corporate governance.
- *Full data integration.* All the major databases used in a general practice are linked together and the data integrated into one space (data warehouse).
- *Near-real time Extraction, Transformation, and Loading of the integrated data* into a single Data warehouse.
- *User-centred KPI design, monitoring, and visualisation through custom dashboards.* Through extensive user and stakeholder consultations, our field study has identified a set of common operational and corporate KPIs for primary healthcare. The BA system should allow the specific indicators used by General Practice directors and clinicians to be custom-designed, user-defined, and visualised through custom-made and reconfigurable Dashboards with customised or personalised User Views.
- *Intervention management and assessment.* The system design should also consider how changes and interventions to the operational or corporate processes or to the GP organisation at large should be managed and prioritised using the BI-generated KPI measurements.

A case study for the validation of the proposed BA framework is presented in the following section, through the implementation and roll-out of a BA tool based on this framework.

3. Implementation Case study: The implementation and roll-out of a Business Analytics tool to support primary care management and decision making in London

AT Medics, established in 2004, are London's largest provider of Primary Healthcare services. AT Medics is led by six GP Directors spread across 17 CCG areas, caring for over 500,000 patients across over 43 Primary Care sites, including Urgent Care Services. AT Medics provide core General Medical Services as well as a diverse portfolio of enhanced services, employing over 600 members of staff (including more than 180 General Practitioners).

Up until 2016, the main processing and decision support tool in AT Medics practice had been a spreadsheet, which was manually completed with data coming from the various systems and managed by human data analysts. This process was time-consuming, resource intensive, inefficient, and cumbersome in many ways.

The implementation of the BA tool in the AT Medics organisation was carried out in the following **4 Phases:**

Phase 1: Process Mapping and Requirements capture

The first phase of the development of the new BA tool included a mapping and requirements capturing exercise, where a wide consultation with AT Medics staff, and stakeholders and a detailed mapping of existing processes to support key business decisions were conducted applying the proposed BA framework (and considering all its main elements as described in the previous section). The main output of this first stage was a context-specific model of process monitoring and generic BA system architecture for business analytics and decision support in primary care population management.

Phase 2: Technical design and development

The next phase completed the work on the architecture, design, and development of the bespoke BA system, including the data warehouse and personalised dashboard design, engaging all users and stakeholders. Primary care data is not always in the desirable form, and there are significant variations of coding standards across the healthcare system. The data extraction layer was completely developed from scratch in the R language. The implemented BA tool works as a super-class data layer for the entire GP organisation digital infrastructure. The developed BA engine has some unique features and mechanisms to process data, such as the application of Machine Learning (Bayesian) algorithms to check data discrepancies prior to updating the Data Warehouse.

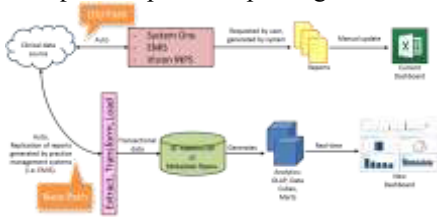

Figure 1. Primary Care Data flows in AT Medics management across the two paths: [Old Path] the previous("current") path without BA (with spreadsheet tool); and [New Path] the new path with the BA tool.

Phase 3: Change management and staff training for BA tool adoption

The third phase delivered specially-designed workshops on change management for all key staff and stakeholders which were essential for the broad adoption of the BA tool,

along with learning and training sets (formalised and evaluated) to train staff on how to make the best use of the tool.

Phase 4: Roll-out across the organisation

The work required implementation and rolling out of the tool across all practices in the organisation and with parallel development of central management review systems. The work also entailed special projects including: remote management of new premises; improved management of existing sites; evaluating new clinical pathways; and new job roles [3]. The example in Figure 2 shows a special dashboard used to monitor performance on patient attendance rates and waiting times.

Thus, the key outputs of this work include a fully implemented BA tool with appropriate functionality and usability, validated by the ATM Board and users/employees (through iterative requirements analysis and usability testing), and "blended learning packages" for staff integrated with AT Medics workshops and learning sets [3,4].

Along the way, the major challenges and barriers in the implementation and successful adoption of the BA tool have been in the following areas: change management and strategic success evaluation; Information Governance and data security; Transferring strategic R&D vision to the industry; and Managing communication, interests, and expectations.

Figure 2. A typical dashboard view used to monitor performance on patient attendance rates and waiting times (courtesy of AT Medics).

Furthermore, the introduction of the BA tool was found to have a direct positive impact on care quality outcomes in various aspects, such as in NHS influenza campaign, diabetes 8 care processes, and triple target and improvements in medicine safety:

1. *Improving flu vaccine rates*: Using the BA dashboard tool to track performance and drive take up of new approaches in 2016, 20% more patients received flu vaccinations than in the previous year.
2. *Optimising medicine use*: The BA dashboard tool proved effective in identifying and visualising a significant gap between best practice and practical application, enabling a step-change in medicines optimisation and safety. The introduction of the approach, has resulted in: a 53% reduction in the number of people with asthma who are taking beta blockers; a 43% reduction in patients with a long-term repeat prescription for non-steroidal anti-inflammatory drugs (NSAIDs); a 26% improvement in the monitoring of patients on disease-modifying anti-rheumatic drugs (DMARD); a 64% improvement in the completion of lithium monitoring; and a 71% improvement in the number of patients on warfarin who are receiving appropriate monitoring.
3. *Improving diabetes care*: Diabetes 8 Care Processes (86% achievement): Increase in control of all three outcomes for Type 2 Diabetes (BP, Cholesterol,

and Hba1c) from 40% to 47% across the organisation within 9 months, representing 7% improvement.

4. *Wider impact on primary care quality, in terms of*:
   - Improving the General Practices' ability to assess, compare, evaluate, and improve performance across all sites, and ability to effect major improvements;
   - Enabling easy analysis of operational performance;
   - Supporting and enhancing decision support processes;
   - Enabling predictive modelling, and application of prescriptive analytics;
   - Offering an agile, flexible, and scalable BA infrastructure.

Overall, the developed BA dashboard tool provides real-time information to enable simpler and faster decision-making processes and to inform business transformation in many areas, and has enabled a new approach to manage information and facilitated the implementation of new processes and systems in an efficient and informed manner. Before the intervention, the task of data collation across 19 General Practices took approximately a week, and at least 12 people would be involved in this task. This is now fully automated. Furthermore, the BA tool is much more economically efficient than existing solutions, as commercial platforms would typically charge significantly more (approximately £1000 per added practice) – and it is easily scalable. It takes less than 10 minutes to add a new practice on to the implemented BA platform, no matter which specific/proprietary information system is being used by the practice.

Conclusion

This paper considered the potential of statistical process control for supporting management decision making in a healthcare context, and explored new possibilities for identifying effectiveness and measuring the value of interventions in healthcare using live clinical data. Its main contributions are the development of a conceptual BA framework for primary care management, and the development of a BA dashboard tool to support management and decision making in primary care, based on the BA conceptual framework and demonstrated through a case study of the implementation of the BA dashboard tool in London's largest primary care provider.

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References

[1] NHS (2014) Five Year Forward View (NHS Long Term Plan), October 2014, accessed on 26/6/2022 https://www.england.nhs.uk/five-year-forward-view/

[2] NICE (2016), "Developing NICE guidelines: the manual", National Institute for Health and Care Excellence.

[3] Ettefaghian A., de Lusignan S., and Stergioulas L.K. (2017), "Business Analytics in Healthcare: An Innovative Quality Management Dashboard", presented in the proceedings of the "*International Workshop on ENTREPRENEURSHIP INNOVATION & TECHNOLOGY TRANSFER*", at Istanbul Aydin University's Florya campus, 23 Nov 2017, Turkey (conference panel presentation, peer reviewed)

[4] Facey KM. Health technology assessment. InPatient involvement in health technology assessment 2017 (pp. 3-16). Adis, Singapore.