Business intelligence and capacity planning: web-based solutions

Income (activity) and expenditure (costs) form the basis of a modern hospital's 'business intelligence'. However, clinical engagement in business intelligence is patchy. This article describes the principles of business intelligence and outlines some recent developments using web-based applications.

In 2500 BC 20 000 men started building King Khufu's Great Pyramid (*Figure 1*). It took them around 20 years and it was the first of many. The men involved in construction included labourers, miners, masons, engineers and architects. If King Khufu had wanted two pyramids, he would have needed 40 000 men and for three, 60 000 men. Or, if he wanted a 'quickie' delivered in 10 years, he would still need 40 000 men unless, of course, they developed novel and efficient technologies.

Hospital business intelligence and world class commissioning

Mathematical calculations form the basis of business intelligence. A commodity or product emerges from a series of steps with resources in place for an iterative 'production line', processing raw materials into a product which results in profit. The production line needs to be regularly monitored for capacity, activity and demand. Good business intelligence is the basis for drug development in the pharmaceutical industry, changes in the number of ticket barriers on the London Underground or toll-booths at the Dartford Crossing.

The need for hospital business intelligence and capacity planning

Rapid increases in demand threaten the sustainability of cancer, hepatology, cardiology, endocrinology, genitourinary and renal services. A statement by the Academy of Royal Colleges and the Department of Health, among others, declared: 'All clinicians should understand the basics of NHS finance, the role that finance plays in their work and how they commit resources' (Audit Commission et al, 2009). Business intelligence uses data on capacity, activity and demand to understand the commercial basis of hospital health care. Service line reporting is business intelligence for individual hospital departments which gives high level procedure and specialty cost information (Monitor, 2007). Business intelligence is required for new departmental builds and extensions and, as an ongoing, iterative process, it encourages research and innovation.

Figure 1. King Khufu's Great Pyramid.

World class commissioning

Monitoring health business intelligence is the prime responsibility of individual hospital finance directors, but is a collective responsibility for all hospital managers and clinicians. Planning or commissioning is the process of deciding the best services, outcomes or health products for society, acquiring them and ensuring they meet requirements (Care Services Improvement Partnership, 2009; Department of Health, 2009). Successful world class commissioning is determined by agencies across therapeutic areas working in partnership and adequately monitoring their performance. Planning and procurement by primary care trusts, hospital doctors and managers should be considered on a 'cradle-to-grave' basis, in light of best current practice and future trends. Cardiology is one example of a rapidly changing service. Although deaths from infarcts have more than halved in the last 15 years, the number of patients with chronic heart disease needing community support has increased. Primary percutaneous coronary intervention returned services from thrombolysis by community paramedics back into hospitals, but at fewer, more specialist, sites (Department of Health, 2008).

Capacity, activity, demand

Increasing demand in the fourth dynasty pyramid business required understanding of the current situation and what the future held. This entails measuring capacity, activity and demand, three variables used in business intelligence.

Capacity

Capacity is all the resources on the 'production line' that delivers your 'health product' and is closely linked to

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expenditure or (reference) costs. The highest costs usually relate to staff salaries. Resources include the quantity of equipment available multiplied by the hours of staff time available to run it. The best approach is to map what happens in each individual service, identifying the steps and the resource it uses. Understanding reference costs emerges from the integrated care pathway (*Figure 2*). All hospitals have to submit reference costs to the Department of Health to inform payment by results tariffs like HRG4 for reimbursement. Benchmarking often shows wide variations.

Service specification: redesign the care pathway or buy new equipment?

Service specification is the process of describing what the future integrated care pathway might look like relative to the old. Organizations like the Modernisation Agency, Institute for Healthcare Improvement and NHS Institute for Learning, Skills and Innovation focus on improving productivity by rapidly spreading new ways of working. Productivity is often achieved by combining pathway redesign, increased capacity and innovative technology. Preoperative assessment and discharge planning is one example of productivity, with improvements in bed and operating theatre use. As a result, cancellations are reduced and the need for increases in theatre capacity or bed capacity may be less than expected (NHS Institute for Innovation and Improvement, 2009).

Technical innovation usually improves productivity. In fourth dynasty Egypt wheels, levers and pulleys gradually replaced human muscle. Innovation makes commercial sense, drives competition and increases profit. Modern radiology, surgery and pathology are more technology-based than mental health or dermatology. One example of improved health productivity as a result of technical innovation is minimal access surgery. Following initial investment in operating theatre machinery and staff training, patients stay in beds for shorter periods and recover at home more rapidly (McCormack et al, 2005).

Activity

Activity, output or product is a rate of all the work done in a given time and is the source of the hospital's income. How you count your work determines how you are paid for it. Counting activity is done by agreeing a 'currency'. There were no pension schemes for the slaves who built the pyramids but they had to be fed and watered. Today the financial basis of business intelligence is agreed with commissioners, e.g. attendances (bed-days, day cases or outpatients) or 'results' (Department of Health, 2007). Radiotherapy treatments, for example, are delivered as daily (Monday–Friday) fractions and a course of treatment for breast cancer patients is usually 20 fractions in 4 weeks. Payment by results would move radiotherapy from fractions as currency to a course of treatment as currency.

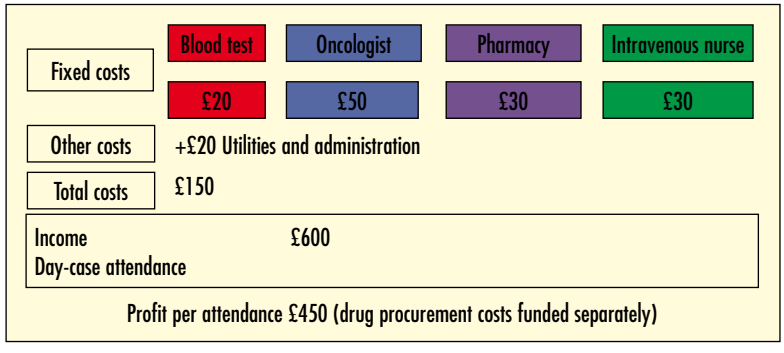
Productivity is the ratio of activity to capacity. If there is no change in capacity (resources), productivity is the rate at which all of the steps on the integrated care pathway function or, more often, do not function together. The productivity of a 9.00–17.00 radiology department is the rate at which scheduled, elective patients are dealt with during the working day using the staff and equipment available. Improved productivity would increase the number of patients seen without increasing staff and equipment.

Demand

Demand, like activity, is a rate and is all the referrals to a department in a given time. Reducing waiting lists (from referral to first treatment) to 18 weeks in the NHS effectively increased demand for (i.e. the rate of) surgical operations and was met by an increase in activity of (i.e. the rate of) operations. Business intelligence predicted how many extra hips, cataracts and hysterectomies would be needed each month. Demand needs to be measured in the same currency as activity: pyramids, motorcycles or payment by results health products. The demand for pyramids in fourth dynasty Egypt was one per 20 years. Demand fluctuates and in most hospitals, activity reduces after 17.00, at weekends or during bank holidays when some departments, e.g. oncology, are closed.

Why predict demand? The guiding principle of the Stock Exchange is to make money by predicting demand and investing in forecasts. If this were an exact science there would be fewer bankruptcies, crashes and recessions. Hospital demand prediction starts with recognition of a future need and drivers (*Figure 3*) and becomes more accurate with clinical engagement (primary, secondary, tertiary sectors and public health). Planning a response to demand reduces danger to patients and burn-out of over-worked staff. Doctors are essential to help predict the big changes in health technology, e.g. minimal access surgery, acute coronary angioplasty.

Figure 2. Integrated care pathway for chemotherapy: putative reference costs and profitability using attendance as currency.



Developing a business case

Achieving consensus

Business cases are the language by which hospital departments communicate their needs to each other and to the hospital board, shareholders, commissioners and the public. Business cases are essential to demonstrate a series of logical steps that will result in cost-effectiveness, value for money or return on investment. Outcomes and benefits

realization refers to effectiveness, value or return on investment and which outcomes will be measured ('metrics') to show benefit. A metric like the quality-adjusted life year, used by the National Institute for Health and Clinical Excellence (2009), defines cost-effectiveness through a year of life adjusted for its quality or its value.

Capital expenditure is required for all items with a usable life of over 1 year. Large NHS capital procurements are subject to parliamentary and public scrutiny. The Public Finance Initiative for new hospitals has received mixed press since its inception in 1997: it has delivered 70 operational hospital schemes worth £4.5 billion, but they effectively saddle the NHS with a mortgage to pay over 30–40 years. When all 126 NHS schemes are in operation by 2014, repayments are expected to rise to £2.3 billion per annum (Northern Ireland Public Service Alliance, 2008).

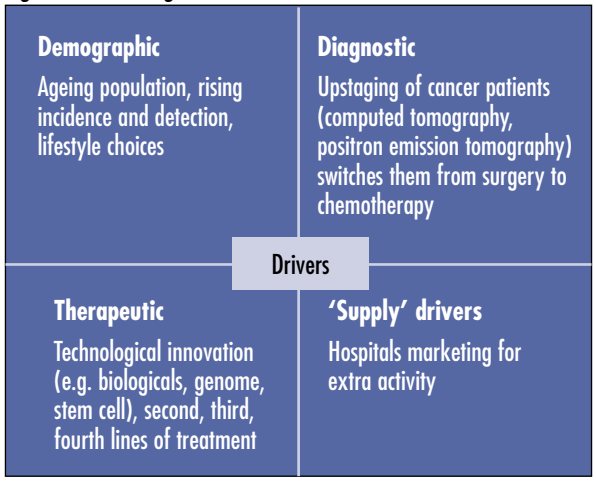
Algorithms and options appraisal

The business intelligence section of a business case sets the proposal for innovation against a series of alternatives, including 'do nothing'. The integrated care pathway is an algorithm and the options manipulate steps within the pathway. The 'Map of Medicine' (www.mapofmedicine.com) holds internationally agreed integrated care pathways. Options appraisal requires an understanding of the principles of algorithms. Algorithms are sequences of finite instructions used to make choices and are widely used for calculation and data processing for call centres such as NHS Direct and web applications such as the Google search engine or electronic chess. Algorithms are often represented graphically as flow-charts or pathways.

Using interactive IT technology

Electronic algorithm manipulation for health capacity planning and options appraisal is usually based on commercial applications like Excel and Access. Producing a business case requires a series of options and IT applications ensure their appraisal is transparent, detailed and robust.

Figure 3. Predicting demand for health care.



Oncology services: chemotherapy and radiotherapy

Chemotherapy service in crisis: root cause analysis

There have been impressive improvements in cancer care since 2000, but there has also been a massive, exponential (~15% per annum) increase in the demand for cancer chemotherapy. This demand is likely to continue and is associated with a number of challenges which have not been addressed by the 'cancer peer review' process, including lack of capacity planning and 'postcode' variation. Three independent reports identified inadequate business intelligence as one of the root causes of the crisis (National Confidential Enquiry into Patient Outcome and Death, 2008; National Patient Safety Agency, 2008; National Chemotherapy Advisory Group, 2009).

Cancer planning online resource tool

In January 2006 the Pharmaceutical Oncology Initiative Partnership selected management consultants A.T. Kearney to design and deliver a national, web-based capacity planning tool (C-PORT) under the guidance of a steering committee of representatives from the NHS, Department of Health and the sponsoring pharmaceutical companies of the Association of the British Pharmaceutical Industry.

A.T. Kearney assembled a team of specialists in health, operations management, microeconomics, and IT to execute the project, and selected UK-based technology partner, Concentra, to build the final web-based version of the tool (*Figure 4*). C-PORT uses advanced modelling and simulation techniques to tackle the problem of capacity planning, and is now implemented throughout the NHS. C-PORT users can simulate how patients and staff will experience care in different scenarios, including how long patients will wait, who they will see and when.

C-PORT: examples of benefits realization

Chemotherapy units can use C-PORT to predict and implement the effect of altering the scheduling of patient arrivals, the staff 'shift' pattern and preparing drugs in advance. One unit, for example, was able to identify and reduce bottlenecks for pharmacists in the early morning

Figure 4. Cancer planning online resource tool (C-PORT) dashboard.

and for nursing staff mid-morning. As a result they are now treating a caseload 11% higher without increasing the number of staff (Geary and Small, 2009).

NHS IT procurement

In many hospitals electronic applications are stored on individual computers which may have no web access or operate out-of-date software so hospital IT departments have to download or be sent new CD-ROM versions of applications. Equations and data stored in Excel and Access can be manipulated by the user so there is no guarantee of long-term integrity or compatibility with other users. Since many NHS terminals were installed web-based interactive digital technology has revolutionized informatics, banking and leisure and the E-health industry is growing rapidly. Digitized web data are accessible anywhere in the world. In radiology, pathology and endoscopy, for example, the telemedicine data acquisition facility does not need to be on the same site as the data interpretation facility. Web-based data do not require the simultaneous presence of both patient and doctor and can be accessed anywhere.

However, many are still concerned that national IT web-based health procurements might compromise patient data (British Medical Association, 2008) and that web-search engines remain commercially orientated; in a recent search for 'earache' the first result was for a rock group of that name. Many public sector IT procurements have a chequered history. Connecting for Health, the National Programme for Health IT was beset by software delays, the acrimonious departure of two large suppliers, Accenture and Fujitsu, and the resignation of the Chief Executive, Richard Grainger in 2007. However, the procurement of both C-PORT and R-PORT were on schedule, had widespread uptake and won a number of awards.

Conclusions

The success of C-PORT suggests that national, web-based applications have advantages for the NHS. They make sense for a variety of emerging specialist services like positron emission tomography scanning, interventional radiology and transplant which are highly technology-based, particularly when technology is rapidly changing. BJHM

KEY POINTS

- Increasing demand for some hospital services in the current financial climate raises doubts about their sustainability.
- Hospital doctors who manage their own financial affairs understand the importance of income and expenditure, the basis of NHS business intelligence.
- Clinical engagement in business intelligence is patchy, but is critical for the way finance managers define capacity, activity and demand for individual hospital departments (service level reporting).
- By assisting in business case development, doctors help managers understand a series of options for change including innovation and modernisation.
- Doctors helped develop modern interactive web-based business intelligence applications like C-PORT and R-PORT in oncology.
- National procurement of these applications, using support from professional organizations and industry, makes sense for a variety of low-volume, high-cost services.

Conflict of interest: Professor James sat on the Pharmaceutical Oncology Initiative Partnership Steering Group for the commissioning of C-PORT from Concentra and has assisted in the development of R-PORT and C-PORT financial models.

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