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The Rise of Big Data and Can it be Used to Compare International Healthcare in Orthopaedic Surgery?

Andrew Gordon

In this brief review article I endeavour to give clinicians an understanding of Outcomes Research and briefly describe how it may assist future resource planning. We now live in the era of Big Data, a description of datasets so large and complex that standard or typical analytical processes cannot cope with the interpretation or analysis. This data generation occurs across all industries, and is a resource that could be used to improve global healthcare.

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Within the UK there are many examples where Big Data has been captured and is being used in an attempt to improve delivery of healthcare and clinical and patient-related outcomes.

The BOA is leading the way with the Quality Outcomes Project[1] and is assisting with eight emerging registries or audits. In addition, at a national level, the National Joint Registry (NJR), National Hip Fracture Database (NHFD) and the Trauma Audit and Research Network (TARN), contribute significantly. In the UK, the Health and Social Care Information Centre collects details of all patient admissions, outpatient appointments and Accident and Emergency visits and records each period of care as an 'episode'. These administrative Hospital Episode Statistics (HES) can be used by national regulators, healthcare providers and 'service users'. Numerous other international general and specific datasets are also in existence, examples include; The Swedish, Norwegian and American Joint Replacement registries and the Australian Institute of Health and Welfare Statistics and The California Office of Statewide Health Planning and Development Database.

However, despite this abundance of data, significant challenges remain, including how we want this disparate data to work for us and how to meaningfully analyse, share, validate, and interpret it. For most clinicians, this new vista remains unexplored however increasing numbers of medical professionals are engaging in the domain of outcomes research.

Most clinicians will be familiar with the concept of 'levels' of medical evidence and clinical trials; most will also be aware that there is a paucity of higher level trials in orthopaedic surgery. The current gold standard trial

remains a randomised clinical trial (RCT). The RCT is an excellent method to compare therapeutic variables but may not reflect a 'standard' hospital's practice. The generalisability of RCT studies to physicians and hospitals not part of the original trials are well documented;[2] and extrapolation of 'outcomes' is problematic. Outcomes research is a methodological technique that analyses all patients (usually from large specific databases) and reflects population heterogeneity. It also assesses the 'provider' and considers variables such as volume number, teaching status and subspecialisation. Dataset analysis involves large numbers of patients which permit powered subset confounder analysis, however it still requires hypotheses, inclusion and exclusion criteria, outcomes/endpoints, comparison groups and covariates. It is not data mining but is a robust analytical process. This method of research therefore still analyses outcomes but the emphasis is at physician, hospital, national and international level.

Publication of outcomes research using national datasets is increasing, and there are numerous examples of international orthopaedic publications from the Australian Orthopaedic Association NJR Registry[3], The Danish National Registry[4], and the Norwegian and Swedish Arthroplasty registries. In the UK, the seminal paper by Smith et al reported the outcomes of metal on metal arthroplasty and its inherent issues[5]. To date, there are twenty five publications listed on the UK's NJR website linked to research using the NJR data set. However, there remain challenges. It seems apparent following discussion at the recent British Hip Society AGM that currently the NJR may not be a valid tool to analyse data at individual surgeon level and there was much debate concerning the data for reporting outcomes at unit level. NJR aside, whatever 'level' of analysis the datasets are used for, questions about the validity of their use remains. For example, in a recent paper, Sabah et al conclude that the NJR underestimates the revision rate for metal on metal hip replacements[6]. Ongoing validation programmes to improve the data, hopefully negating these questions in the future, are in place for all clinical registries.

An additional approach to outcomes research is to use administrative data. One criticism levelled at administrative datasets is that the data is not collected by clinicians but by coders with limited understanding of the complexities of medical care. However, there is robust training for coding staff internationally and inaccuracies which may occur tend to be random and therefore unlikely to bias findings. Administrative databases are not meant to replace clinical data registries but they may complement each other. Chang et al have used the analogy of screening and diagnostic tests when analysing outcomes from administrative datasets and clinical databases[7]. Outcomes generated from analysis of administrative data which are sensitive but not necessarily specific should not be dismissed but should instead be followed up, potentially by analysis of the clinical databases. The sheer volume of useful data contained within the administrative dataset, in some ways greater than that stored in clinical databases, and certainly far greater than that of RCTs, make it wrong to dismiss the findings of administrative dataset outcomes research. In the UK, HES data has been analysed and publications produced in the areas of mortality after fractured neck of femur, outcome after total hip replacement and the incidence of pulmonary embolus after joint replacements[8-10].

The recently published GIRFT report[11] states, *"With a projected NHS savings requirement of £20 billion by 2015, against a background of an ageing population with an increasing requirement for orthopaedic treatment, there must be an attempt to address provision of care which accounts for 80% of the total cost".* We in the UK are not alone in this predicament. Health service provision worldwide is under severe strain. The Organisation for Economic Co-operation and Development 2014 report states that health spending across OECD countries is a mean of 9.3% of GDP and is rising. However, there are vast differences. For example, in the USA, healthcare accounts for 16.9% whereas for the UK and Australia it is 9.3% and 9.1% respectively. Are the clinical outcomes different in each country? Are we treating vastly different populations? Are we getting value for money? Until recently it was difficult to attempt to answer this question as international comparison using these vast datasets was not possible. However, recent collaboration between countries has been attempted.

Dr Foster Global Comparators started in 2010 with the aim to bring together data from hospitals in different countries, translate the data into a common language, commence research and compare the results openly. This is only possible however when clinicians and healthcare providers share their knowledge and understanding in order to improve patient outcomes; a goal championed by Lord Darzi in the

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∞*THERE REMAIN CONSIDERABLE CHALLENGES WHEN COMBINING ADMINISTRATIVE DATABASES, NEVERTHELESS IT IS POSSIBLE TO DEFINE IN-PATIENT ADMISSIONS, DIAGNOSTIC AND PROCEDURE GROUPS AS WELL AS ADJUST FOR CO-MORBIDITY AND PRODUCE RISK ADJUSTMENT MODELS.*∞

foreword to the GIRFT report. Currently there are six Global Comparators (GC) groups; including Gastrointestinal (GI) surgery, Health Economics and Orthopaedics. Global Comparators started with 31 organisations in five countries which have grown to 45 organisations in ten countries. Each hospital within GC provides HES type administrative datasets which are analysed and validated at Imperial College, London. The initial international dataset contained 6.7 million anonymised inpatient records and currently has 20m anonymised inpatient records. There remain considerable challenges when combining administrative databases, nevertheless it is possible to define in-patient admissions, diagnostic and procedure groups as well as adjust for co-morbidity and produce risk adjustment models[12].

Currently in The Orthopaedic GC group we are comparing international outcomes following fractured neck of femur and the effectiveness of revision surgery for prosthetic joint infection in both hip and knees. The numbers of patients analysed in this research is over 55,000 and administrative data is available from four countries. We are currently validating our comorbidity score modelling before statistically analysing the international outcomes data. However, we do hope to have manuscripts for publication within the next month and look forward to peer review.

As for the future, by measuring comparative outcome data, be that at national or international level it is possible to provide meaningful analyses of therapeutic intervention incorporating provider and patient variables. Outcomes research may then be in a position to accurately permit analysis of cost benefits (net costs), cost effectiveness (net cost per net change in years of life) and perhaps most importantly in orthopaedics; cost utility analysis, the net cost per net change in quality of life. Performing this at an international level, with the support of clinicians and healthcare providers may generate meaningful hypotheses as to how to deliver excellent patient outcomes and address realistic provision of care in increasingly austere times.

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References can be found online at *www.boa.ac.uk/publications/JTO* or by scanning the QR Code.

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