ORIGINAL ARTICLE

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Hospital-wide implementation of an electronic-workflow solution aiming to make surgical practice improvement easy

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Abstract

Background: In measuring quality of health-care delivery, digital infrastructure is essential. The aim at this tertiary centre was to create a hospital-wide workflow system that collected data prospectively as part of daily practice.
Methods: In moving towards an electronic health record, a hospital-wide integrated workflow system was introduced in 2013, which electronically managed the perioperative patient journey while simultaneously facilitating surgical audit. Analysis of its implementation was carried out presenting early outcomes using general surgery as an example.
Results: Theatre-bookings (44 953) were made with compliance approaching 90% for all services. Of 7179 general surgical operations over 24 months, 5785 (80%) had an operation note created using the new system. Cumulative summation of uptake of synoptic operative reporting (SOR) for laparoscopic cholecystectomy (LC) was 81% with documentation being superior in terms of antibiotic use and steps to safe cholecystectomy ($P < 0.001$). A LC SOR took 4 min to complete (interquartile ranges 2–5 min, $n = 425$) and was immediately available on the day of surgery compared to narrative operative reports taking 2 days (interquartile ranges 1–5 days, $n = 174$) ($P < 0.001$). From July 2014 to November 2015, 557 (10%) complications were recorded for 5749 general surgical operations with 99% of complications being reviewed.
Conclusion: The rapid and sustained uptake of both theatre-bookings and SOR likely reflect high end-user satisfaction with the system. Service metrics indicate a significant improvement in the time of delivery. The ability to seamlessly complete the audit cycle at an individual, department and hospital level has been achieved.

Introduction

Participation in surgical audit to ensure quality health-care delivery is a requirement of all practising surgeons. Audit can assume many guises[1] and there are many tiers of surgical audit mandated by surgical departments, hospitals, governments or training colleges and their affiliated subspecialty societies. Many of these collect the same information resulting in the duplication and unnecessary double-handling of data entry. This is not only wasteful in terms of resources but also can contribute to inaccuracy and data degradation. Currently, retrospective audits require clinical data to be extracted from ICD-10-coded clinical records which, in New Zealand (NZ), are carried out in isolation by clerical staff. Clinicians have questioned the accuracy and completeness of such data.[2] In moving towards increased public transparency of clinical outcomes and meeting the increasing public and media requests for individual surgeon outcomes,[3] the accurate coding, interpretation and presentation of audit data have become paramount.

As the Canterbury District Health Board (CDHB) moved towards a paperless electronic health record (EHR), the vision at this tertiary centre was to create an electronic-workflow in which data were collected prospectively by clinicians, incorporating it with day-to-day activities such as theatre-bookings, operative reports and, real-time complication documentation. The system needed to be compatible with existing audit and logbook tools already used throughout NZ and Australia and, allow for data sharing. The process of creating this system and early outcomes from implementation across surgical services within a large tertiary centre are described in this paper.

Methods

Background

See Appendix S1.

Solutions committed to operative procedure excellence

In 2012, solutions committed to operative procedure excellence (scOPe) (a perioperative management system designed to prospectively capture clinical data) was licensed to the CDHB to facilitate the process of surgical workflow (Fig. 1). Process-mapping of the patient journey through acute/elective pathways was performed. This enabled a detailed understanding of tasks performed by both administrative and clinical staff in regards to facilitating a patient's journey through the surgical service. Lean-thinking principles were adhered to in designing the end-user interface. scOPe used the Systematic Nomenclature of Medicine-Clinical Terms. Data entry at any stage of the patient journey could be by any clinician with access (house-officer/registrar/consultant), which was password protected ensuring privacy/security. A mobile version of the programme is about to be launched allowing bedside data entry.

Operation notes

scOPe could generate definitive typed operation notes that accompany each patient through to recovery. Booking data (diagnosis/procedure/surgeon/anaesthetist) were auto-populated minimising data entry duplication. Default templates for common procedures could be selected with minimal typing involved, these could be altered, personalized and saved. If clinicians preferred to dictate, only the audit data and post-operative instructions needed to be captured. Several subspecialties adopted the use of synoptic operative reports (SOR): these are listed in Appendix S2.

Early results of this workflow system for general surgery (one of the more advanced users) were carried out. The time taken for narrative operative reports (NOR) versus SOR for laparoscopic cholecystectomy (LC) and appendicectomy (LA) to reach the EHR were obtained through their respective programmes. Uptake for SOR was extracted from scOPe. Documentation for LC was compared between NOR (February–August 2014 – manual data tally from operation note review) and SOR (May–November 2015 – automated process within scOPe).

Audit

Within general surgery, audit data were captured weekly by teams and graded according to Clavien–Dindo.[4] Complications graded 3 and above were presented at weekly Morbidity and Mortality meetings. Weekly acute and elective admissions could be reviewed, serving as a checklist rather than relying on memory recall of isolated complications. Complications were then presented and intervention actioned when the consultant was in attendance at the meeting. scOPe provided subsequent ease of data extraction for target/craft group audits. Individual surgeon key performance indicators were available instantly for benchmarking. Bespoke forms could be created by end-users including subspecialty synoptic pathology reports. Deaths/readmissions were imported from a central registry.

Statistics

Continuous data are presented as medians with interquartile ranges (IQR) in parentheses. Statistics were carried out using *t*-test, Mann–Whitney-*U* or *Z*-score where appropriate. *P*-values were considered significant if <0.05.

Results

Rollout of scOPe was staggered across surgical services. From January 2014 to November 2015, there were a total of 44 953 theatre-bookings (acute and elective). Monthly compliance for scOPe theatre-bookings are shown in Figure 2a (hospital-wide) and Figure 2b (general surgery).

Operation notes

The percentage of operation notes created within scOPe as a proportion of the total operations (15 190 operations) over time are shown in Figure 2c. The uptake of SOR for LA and LC and the difference in the level of documentation between NOR and SOR for LC are shown in Figure 3.

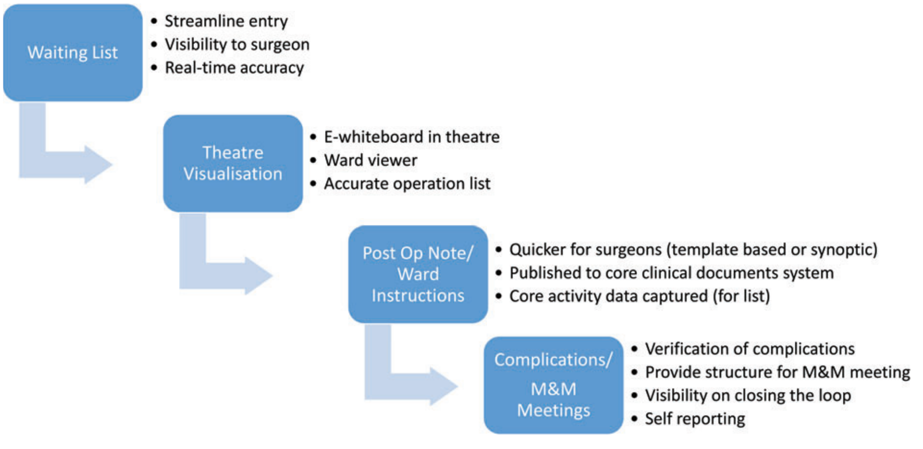

Fig. 1. Demonstrating the process of surgical workflow in solutions committed to operative procedure excellence (scOPe). M&M, Morbidity and Mortality.

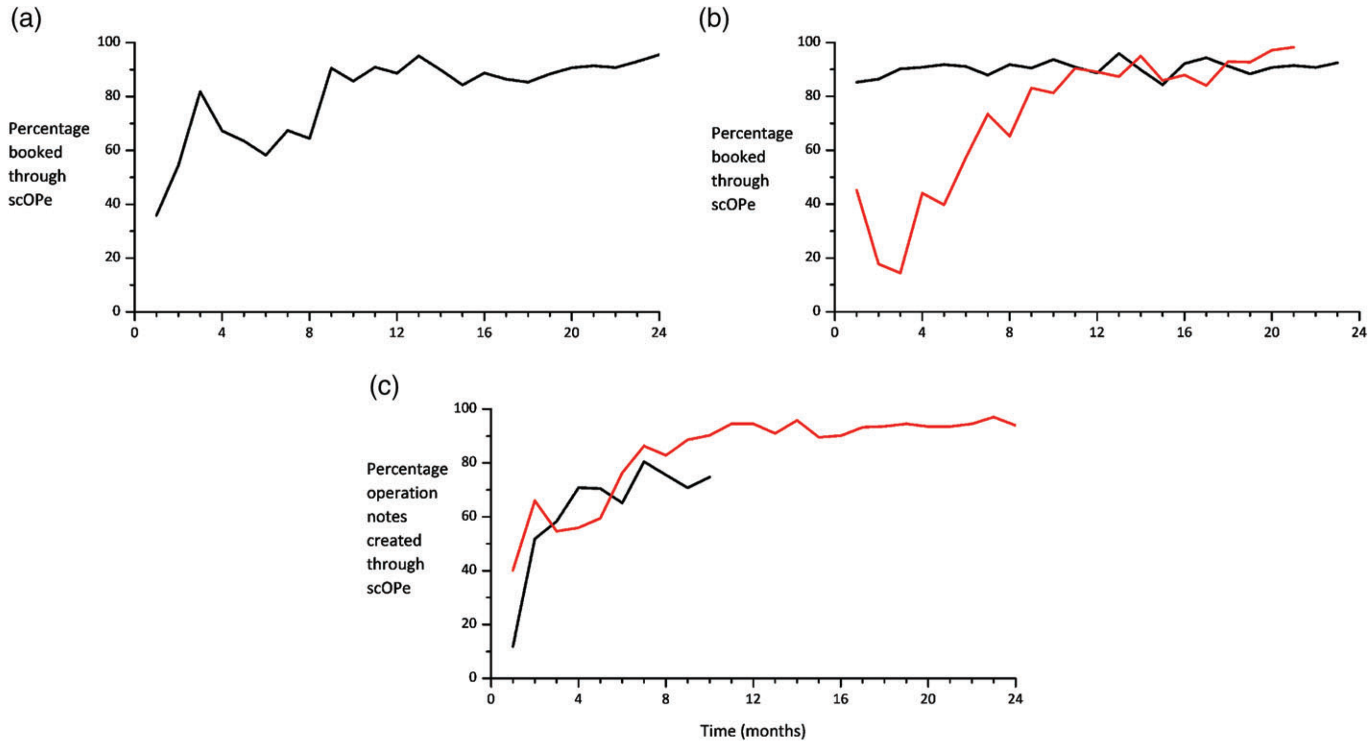

Fig. 2. Median monthly compliance for scOPe theatre-bookings over time from implementation for all services (a) 18 037 acute theatre bookings comprising of advanced users (general surgery: 23 months use, 4556 bookings; obstetrics/gynaecology: 21 m, 3586 bookings; orthopaedics: 24 m, 6674 bookings; plastics: 24 m, 2455 bookings; and others: 881 bookings, median of 5 months) and for general surgery (b) (——, acute (4556 bookings) mandated from start; ——, elective (3285 bookings) which were introduced 3 months later and initially optional). (c) Uptake of scOPe to generate operation notes as a percentage of all operation notes (15 190 operations) created over time (——, all services (7179 operations); ——, general surgery (5785 operations). Note that some bookings would not have generated a note due to cancellations/postponements or procedures such as cardioversion, endoscopy and interventional radiology. Eight services using scOPe over dictation/transcription over a median of 6 months (range 5–24).

Analysis of time taken for dictated/transcribed operation notes to reach the EHR was a median of 2 days (IQR 1–5 days, $n = 174$). Whereas, operation notes published through scOPe were available on arrival to the recovery room (analysis of 4199 operation notes, IQR 0–0 days); $P < 0.001$. A SOR took a median of 5 min (IQR 3–8 min, $n = 425$) for LC and 3 min (IQR 2–5 min, $n = 386$) for LA.

Audit

Between July 2014 and November 2015, 557 general surgical complications were recorded for 5749 operations (10%); 206 (37%) were Clavien–Dindo grades 1–2. Three hundred and forty-six of 351 (99%) complications Clavien–Dindo grade 3 or greater were reviewed at Morbidity and Mortality meetings. There were 27 of 346 (8%) discussed complications that generated intervention to be

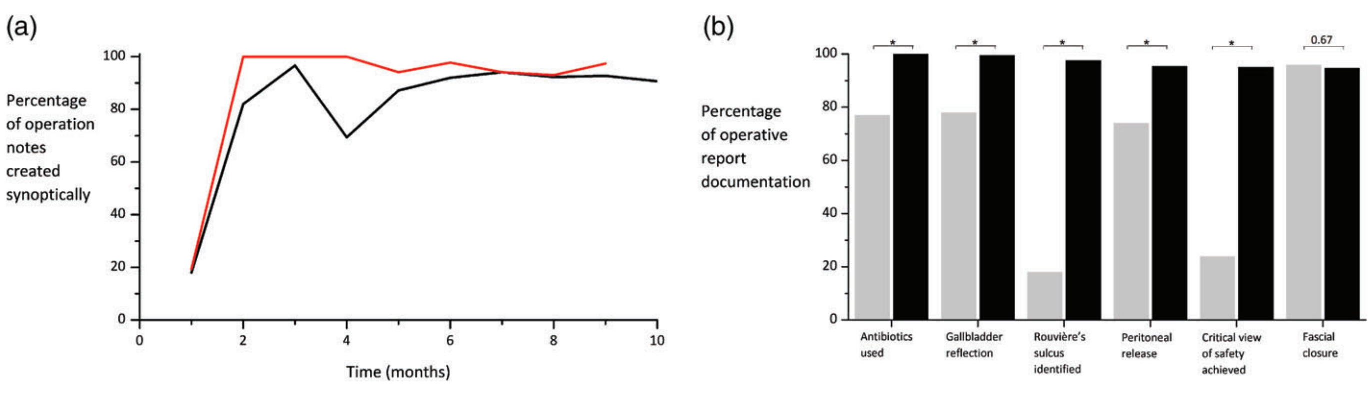

Fig. 3. (a) Uptake of synoptic reports over time for laparoscopic cholecystectomy (LC; $n = 451$ operations) and appendicectomy (LA; $n = 406$). Synoptic reporting for LC was introduced a month prior to LA. ——, LC; ——, LA. Cumulative summation for both LC and LA 81%. (b) Documentation differences between narrative (grey) and synoptic (black) operative reports for LC.

Table 1 An example of key performance indicators for laparoscopic cholecystectomy that are available for a single surgeon's practice

	Individual surgeon			Specialty		
	n	Median	Range	*n*	Median	Range
Length of stay						
Acute	78	3 days	1–19	485	3 days	0–19
Elective	123	0 day	0–3	390	1 day	0–31
Complications						
Acute	7	81	9	11	494	2
Elective	18	123	15	21	392	5
Returns to theatre						
Acute	2	81	3	6	494	1
Elective	0	123	5	1	392	0
Readmissions						
Acute	11	81	14	50	494	10
Elective	23	123	19	52	392	13

actioned at a local level. Table 1 shows examples of LC key performance indicators for a single surgeon benchmarked against the department. These could be filtered by procedure or by higher order criteria, for example, biliary surgery.

Discussion

This tertiary centre has seen the successful implementation of a hospital-wide electronic-workflow system that prospectively collects data entered by clinicians. This includes the ability to create SOR that are not only a more accurate form of clinical documentation but also accompany the patient on arrival to the recovery room and allow for real-time evaluation of health-care outcomes. The system also has the capacity to integrate information with existing registries and databases obviating the need for unnecessary double-handling of data entry and enabling an accurate dataset for audit.

Health systems have been slow to adapt to the electronic-age with many hospitals still using paper-based records. Modern medicine requires a paradigm shift in adopting such change which requires acceptance, adaptation and ongoing coordinated re-engineering.[5] EHRs have been criticized as disruptive to workflow with increased workload related to data entry.[6,7] Some have even criticized EHRs as facilitating billing rather than clinical practice and, when created in isolation without data-sharing capabilities, question whether these systems really do improve patient outcomes.[8] Furthermore, health information systems that fail to support workflow have been identified as one of the top 10 patient safety concerns.[9] The system described here was designed in conjunction with front-line clinicians undergoing constant re-engineering to test integration with workflow. The rapid, sustained uptake of theatre-bookings and SOR seen at this centre likely reflect high end-user satisfaction with the system. Creating scOPe SOR and even NOR is neither time-consuming nor onerous, and the note is published and immediately available in the EHR. There are numerous advantages in this approach. Delaying dictation inevitably results in omissions in details forgotten with time[10] and handwritten notes provide poor quality information for coding.[11] Reduced transcription requirements save cost and time; cost-analysis has not been performed here but others have estimated significant cost savings with SOR.[12] The flexibility to still dictate NOR exists, however, the motivation to complete the audit aspects is incentivized by automated publication of a trainee logbooks and by immediately available, legible post-operative instructions that have come to be expected in the recovery room. Clinicians can personalize narrative templates where they are used (again less typing), and the system 'learns' each surgeon's frequently booked procedures linking them to diagnoses and *vice versa*, minimizing the impact such systems can have on clinician time and alleviating resistance that may be encountered where lack of flexibility or redundancy exist.

NOR, which have been for many years the standard documentation of any operation, are not standardized and can be of variable quality and completeness.[13,14] Interestingly, the most complete NOR can contain information on the least important parts of the procedures with fewer long-term implications.[14] Whereas information key to long-term outcomes, such as details of resection, margins (R0, R1, R2) and lymphadenectomy extent were frequently omitted for those undergoing pancreaticoduodenectomy[13] or surgery for rectal,[14] breast[15,16] and thyroid[17] cancers. This is again demonstrated here where the steps to safe cholecystectomy[18] are better documented with SOR when compared to NOR. The ability to also include narrative text in SOR means that these notes are not just auto-populated, homogenous documents that struggle to convey meaningful recall of an operation.

Inadequate documentation can result in medicolegal vulnerability so it is surprising that despite the importance of the operative note as a clinical document, little formal training occurs on how to dictate them.[19,20] In countries where the operative note serves to aide financial reimbursement, incomplete documentation results in losses for the institution.[21] Furthermore, the narrative approach does not lend itself to easy data extraction for audit/research. Synoptic reports facilitate clinical communication between specialists and are now the standard of care in histopathology reporting for melanoma, breast and bowel cancer in NZ.[22]

Additional benefits from the new system have extended to surgical training in terms of operative documentation and logbook generation. Participation alone in an operation does not always give trainees enough understanding to then dictate a comprehensive operative narrative[10] and NOR dictated by surgical registrars omit more information than those that were dictated by more senior attending surgeons.[21] Even where fields are not mandatory, simply the presence of a tick-box prompts documentation of salient steps resulting in more information being included in SOR.[23]

The other benefit to trainees at this centre is the ability to generate a logbook within the framework stipulated by local training organizations. The ideal logbook should import data from existing hospital systems to reduce duplication of data entry and improve accuracy[24] but this is yet to occur. Significant progress was made with the introduction of RACS initiated web-based solutions to facilitate automatic tallying of trainee case-mix and level of supervision. However, logbooks are still honesty-based and no further verification of actual operations performed has been possible until now.

scOPe has given both individual surgeons and theatre managers visibility of theatre waitlists and occupancy. Theatre occupancy times for each procedure are calculated as a median-time based on past performance of that surgeon. When future lists are created, occupancy is more accurately estimated which will reduce unnecessary cancellations that arise from overbooked lists or suboptimal theatre utilization in under-booked lists. Theatre views, which are accessible from any computer in the institution, allow at-a-glance assessment of slow running theatres and for theatre managers to reassign theatres that finish early, optimising staffing/theatre allocation. Each surgeon also has access to their most up-to-date waitlist and uses a first-in-first-out concept resulting in fairer access to elective surgery.

Throughout NZ and Australia, several electronic audit/logbook systems have been trialled successfully[25,26] but these have been generally created and used in isolation. Few have the capability for data export or integration with existing registries and databases. This has resulted in the explosion of databases that often collate identical information leading to unnecessary re-entry of data, sometimes necessitating the employment of data managers that can be costly in a resource-constrained health system as well as leading to potential data degradation. Furthermore, prospective data collection is measurably more accurate than retrospective data collection through coded medical records[27] which are often compiled by non-clinicians. Even something as seemingly dichotomous as mortality, has been shown to be incorrectly coded at this centre.[2] Here, the quality of the data should be assured as clinicians enter it prospectively alongside their day-to-day activities.

Development of this workflow system has been evolutionary with constant re-engineering and troubleshooting to create a system that was effortlessly integrated with day-to-day surgical practice. One problem with the system is that entry of complications is still voluntary/honesty-based and relies on individual clinicians to maintain their audit integrity. Readmissions and deaths, which are now automatically integrated from a central database, still need cross-checking to ensure that they are relevant to the patient's recent surgical admission. Tools such as the timed 'up and go' (TUG) score[28] and the Edmonton Frail Scale[29] will be used to incorporate the risk and complexity of patients undergoing surgery as those surgeons operating on higher-risk patients or performing redo surgery may have disproportionately higher complication rates. There is also potential to add pre-operative assessments, pathology and comorbidity to enrich the data. This system allows for data sharing with organizations outside of the District Health Board such as RACS subspecialty societies or local cancer registries. scOPe roll-out to other District Health Boards around NZ would make a nation-wide system of surgical audit feasible given the common need for accurate audit, limited national resource to develop such projects and the small population size in NZ. This would create a meaningful national dataset of surgical health-care outcomes and allow for nation-wide benchmarking of surgical practice. The potential for accurate audit and the wealth of research generated from this prospectively collated data, real-time key performance indicators measurement and measure of health-care delivery is unsurpassed and should be incentive enough to participate even if this is not yet mandated by government. In the era of big data, this should be the standard of care.

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Supporting information

Additional Supporting Information may be found in the online version of this article at the publisher's web-site:

Appendix S1. Background.
Appendix S2. Services using synoptic operative reporting.