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Original Research Article

Effects of a team Quality Improvement method in a national clinical audit programme of four clinical specialties in Ministry of Health hospitals in Saudi Arabia

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Abstract

In 2018, the Ministry of Health (MoH) in Saudi Arabia developed a clinical excellence strategy. An objective was to reduce variation in clinical practices in MoH hospitals, particularly for conditions with high mortality in Saudi Arabia, by applying best practice clinical standards and using the clinical audit process to measure clinical practice. The strategy included working with multiprofessional teams in hospitals to implement improvements needed in clinical practice. To test the feasibility of carrying out national clinical audits in MoH hospitals, audits were carried out in 16 MoH hospitals on four clinical subjects—acute myocardial infarction, major trauma, sepsis, and stroke. Clinical expert groups, including Saudi clinicians and an international clinical expert, developed clinical care standards for the four conditions from analyses of international and Saudi clinical guidelines. The audits were designed with the expert groups. Multiprofessional teams were appointed to carry out the audits in designated MoH hospitals. Data collectors in each hospital were trained to collect data. Workshops were held with the teams on the clinical care standards and how data would be collected for the audits, and later, on the findings of data collection and how to use the improvement process to implement changes to improve compliance with the standards. After 4 months, data collection was repeated to determine if compliance with the clinical care standards had improved. Data collected from each hospital for both cycles of data collection were independently reliably tested. All designated hospitals participated in the audits, collecting and submitting data for two rounds of data collection and implementing improvement plans after the first round of data collection. All hospitals made substantial improvements in clinical practices. Of a total of 84 measures used to assess compliance with a total of 52 clinical care standards for the four clinical conditions, improvements were made by hospital teams in 58 (69.1%) measures. Improvements were statistically significant for 34 (40.5%) measures. The project demonstrated that well-designed and executed audits using evidence-based clinical care standards can result in substantial improvements in clinical practices in MoH hospitals in Saudi Arabia. Keys to success were the improvement methodology built into the audit process and the requirement for hospitals to appoint multiprofessional teams to carry out the audits. The approach adds to evidence on the effectiveness of clinical audits in achieving improvements in clinical quality and can be replicated in national audit programmes.

Keywords: national clinical audit; quality improvement; quality improvement methodologies; teamwork; clinical care standards

Introduction

In 2016, Saudi Arabia launched 'Vision 2030', a transformative strategy to enable the country to become a vibrant society, a thriving economy, and an ambitious nation. The healthcare system is one of the eight specific transformation programmes [1, 2]. The healthcare system transformation programme is based on delivering value-based care, implementing and following the best evidence-based international standards, and improving the quality of health services [3, 4]. A Model of Care programme was initiated to develop clinical guidelines based on evidence-based clinical practices, drive value-based care, reduce variations in patient care, and support accountability for the quality of clinical care [5].

In 2018, responding to the Vision 2030 objectives and the Model of Care programme, the Clinical Excellence General Directorate (CEGD) in the Ministry of Health (MoH) developed a strategy to identify clinical conditions that are leading causes of death or preventable harm in Saudi Arabia and, for those conditions, convert international evidence-based clinical guidelines, including those developed under the Model

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of Care, into key clinical care standards to focus hospital clinical teams on implementing the most important aspects of evidence-based practice. In addition, the strategy was intended to support clinical teams in benchmarking their performance with best international clinical practice, introduce accountability for implementation of best clinical practices, and involve clinical teams in properly designed and executed clinical audits to measure, have feedback on, and improve their clinical practices.

In other countries, the clinical audit process is well established as a strategy to facilitate improving the quality of patient care [6]. In England where over 55 national clinical audits are carried out annually supported by Naltional Health Services (NHS) England [7], a realist evaluation identified mechanisms that support national clinical audits including protecting the healthcare organization's reputation; improving clinical performance; attracting referrals and patients; providing incentives, particularly for improvement; and contributing to professional development [6]. National clinical audits in the UK provide boards of trustees of healthcare organizations with a level of assurance of quality of care, whereas clinical teams use audit data to improve quality [8].

Another systematic realist review carried out in The Netherlands identified factors that explain how audits work in improving the quality of hospital care. Factors identified included externally initiated audits create awareness to improve, knowledge sharing within externally mandated audits triggers participation, audit data support professionals in raising issues with leaders, and audits legitimize providing feedback to colleagues [9].

Working on the Vision 2030 objectives and using evidence on the value of national clinical audits in other countries, the CEGD decided to carry out a national clinical audit programme. The aim was to learn about the benefits and drawbacks of using national clinical audits in MoH hospitals. Four clinical conditions were selected: major trauma, myocardial infarction, sepsis, and stroke.

Methods

The national clinical audits were designed and conducted in accordance with published proposed standards for national clinical audits [10]. The clinical conditions for the audits were selected because of being major causes of death and disability in Saudi Arabia [11].

Development of clinical care standards

Clinical guidelines published in other countries that were developed consistent with the AGREE Collaboration [12, 13] and the GRADE Working Group [14] guidance were analysed to identify the key aspects of care on which there is international agreement and that are known from the evidence to have a positive effect on patient outcomes. Model of Care guidelines for acute coronary syndrome, major trauma, and stroke were included.

These analyses were made available to Saudi expert clinical groups named by the Model of Care programme. Criteria were established by consensus for the selection of aspects of clinical care to be included in the clinical care standards. The criteria were as follows: patient focused (describing what should happen for every patient with the condition under audit); evidence-based; outcome-oriented; multidisciplinary; and feasible to deliver in an acute care hospital. The expert groups worked with the project staff to develop short lists of standards. A total of 52 clinical care standards were developed, 15 each for major trauma and stroke, and 11 each for myocardial infarction and sepsis.

Initially, the Delphi consensus-building method was used by the clinical experts to set priorities for the standards, followed by detailed discussion among the experts. The process for deriving the clinical care standards is consistent with the published practice [15–17]. The clinical care standards were presented with clear explanations about the importance of each standard for patients, for clinicians, and for hospital management. The clinical care standards developed for each audit are in the Supplementary Material.

Each of the clinical audits was then designed in detail with the clinical expert groups. Clinical audit measures were derived from the clinical care standards along with clinical and patient-related exceptions to the application of a standard and detailed definitions and instructions for collecting data and making decisions about compliance with each standard.

Participating hospitals

MoH hospitals are grouped into geographic clusters and managed by Cluster management teams, which in turn are managed by the Health Holding Company. Cluster management teams in Riyadh, Dammam, Al Qassim, and Al Ahsa were approached to support participation in the clinical audits for a total of five hospitals for each subject. Hospitals considered to be leaders were suggested. Each hospital designated for participation in one of the audits was required to specify a multiprofessional clinical team to take responsibility for participating in the audit. The composition of multiprofessional teams was recommended by the expert groups. The responsibilities of the teams were defined and included participating in online workshops to learn about what was involved in carrying out a clinical audit, including making improvements in the quality of care where indicated by the data collected for the audits.

A total of 16 hospitals were designated for participation in the clinical audits, with five hospitals agreeing to participate in more than one audit. Of the 16 hospitals, five hospitals were in either of the two Riyadh Clusters, three in the Eastern Cluster, one in the Al Qassim Cluster, and one in the Al Ahsa Cluster.

Sample sizes for each audit

The numbers and selection of patients to be included in all the audits were determined by the Saudi expert groups on a pragmatic basis consistent with national audits carried out in other countries. For myocardial infarction and stroke, 50 consecutive patients starting from patients admitted as of 16 May 2021 were selected for inclusion in the first round of data collection and the same number of patients admitted starting from 1 April 2022 were selected for the second round. Clinical experts estimated that the hospitals admitted 25 to 30 patients a month for these conditions.

For sepsis, 50 consecutive adult patients assessed and treated in a hospital's emergency department were selected for the first round of data collection, starting from 16 May 2021, and the same number and type of patients were selected for the repeat data collection starting from 1 April 2022.

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Clinical experts estimated that this number would represent about 2 months of patients treated for sepsis in emergency departments. For major trauma, the clinical expert group recommended the inclusion of 30 consecutive patients admitted following major trauma for both cycles of data collection, representing about 6 to 8 weeks of major trauma patients in the participating hospitals. Therefore, the time of year for data collection was approximately the same for both rounds of data collection, and data collection was retrospective for both rounds.

Data collectors were provided with detailed specifications of how to identify these patients and any exclusion criteria.

Data collection

Each participating hospital was required to designate one or more members of staff to collect data. Electronic and paper-based data collection forms reflecting the clinical audit measures were developed and pilot tested. Detailed guides for data collection for each audit were developed, which included explicit instructions for deciding on compliance (yes or no) with each clinical care standard. Data collectors participated in 1-day workshops to learn in detail how to capture data required for each audit and submit data using either electronic or paper-based forms, according to their preferences. Prior to submission of collected data, the data were validated by project staff who visited each hospital and independently repeated data collection for a random sample of patients whose data were captured for an audit. The reliability of data collected was reviewed with each hospital's data collector with discussion on the items for which the data collector and the reliability check did not agree. Data collection forms that contained errors or were incomplete were returned to the hospitals to be corrected.

Workshops

A total of 12 one-day workshops were provided. Four workshops, one for each clinical subject, were provided for multiprofessional teams at the start to explain the clinical care standards, how the clinical audit would work, and the roles of the teams in participating in the audit. Four workshops, one for each clinical subject, were provided for the data collection staff for each of the audits to review question by question how to complete the data collection form and submit the data.

The final set of four workshops for multiprofessional teams was provided after the data from the first round of data collection were submitted and analysed. In addition, two short workshops were provided, one for the individuals who served as data validators for each of the audits and one for data collectors prior to the second round of data collection. All workshops were provided online because of travel restrictions imposed by the COVID-19 pandemic.

Data analysis

All data submitted were quality checked and entered in Excel spreadsheets. Data entry was quality controlled. Data were analysed by quality-of-care measure for each hospital and for all hospitals. Percentages of compliance were calculated for each hospital and for all hospitals for both the initial and repeat cycles of data collection. Reports of compliance were provided to all the participating hospitals and key stakeholders. The z test was used to test statistical significance of the difference in compliance with the measures between the first and second data collection rounds.

Improvement interventions strategy

The workshops provided for the hospital teams after the first round of data collection explained the findings and helped the teams to identify causes of shortcomings in patient care and to make improvement plans. All teams submitted improvement plans developed by the teams and approved within the hospital to the MoH.

Consistent with published implementation strategies [18], the improvement plans included a wide variety of actions to be implemented by the teams, such as changing record-keeping practices and information technology systems, providing training for staff, embedding the clinical care standards into electronic pathways, clarifying staff roles, and establishing priorities for services. The teams had 4 months to implement the actions in their improvement plans before the repeat data collection cycle. They acknowledged that some actions needed, such as those involved in enhancing rehabilitation services and obtaining some supplies, would take longer to implement because of the levels of authority needed to take the actions needed for improvement.

Results

Participation by hospitals

All hospitals designated for participation in the four clinical audits participated fully in both cycles of data collection and all workshops.

Numbers of patients included in the audits

The total numbers of patients included in each stage of each audit are in Table 1. The number of patients with myocardial infarction (MI) is divided into patients with ST-segment elevated myocardial infarction (STEMI) and non-ST-segment elevated myocardial infarction (NSTEMI).

Some hospitals did not have the expected number of patients within the time periods allocated for data collection, either at the initial or follow-up rounds of data collection.

Response by clinical teams to clinical care standards

Of the 52 clinical care standards, only three points were raised by clinical staff in the participating hospitals. Based on UK and US guidelines, intravenous morphine was preferred as the first-line analgesic for patients with major trauma. Some trauma doctors objected, citing instances when they believed that another form of pain relief was safer for a patient. With the agreement of the Saudi expert group, the standard was amended to remove reference to intravenous morphine but to require immediate pain relief for the patient.

Some representatives of one stroke team questioned why a stroke patient's blood glucose level was to be monitored in the first 72 hours if a blood glucose test was done on presentation to the hospital and an HbA1c test was done. Because the purpose of immediate and continuous blood glucose monitoring of stroke patients is to have good glycaemic control in

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Table 1. Total numbers of patients included in four national clinical audits.

Numbers of patients included in four national clinical audits									
		Myocardial infarction							
Major trauma		STEMI		NSTEMI		Sepsis		Stroke	
Initial	Follow-up	Initial	Follow-up	Initial	Follow-up	Initial	Follow-up	Initial	Follow-up
131	87	161	134	70	84	198	122	206	192

the immediate aftermath of stroke, whether or not a patient has diabetes, and HbA1c is intended to be used to assess overall diabetes control over 3 months, with the agreement of the Saudi expert group, no change was made in the relevant clinical care standard.

One cardiac team challenged if screening for diabetes using an HbA1c test needed to be done on admission, as stated in myocardial infarction clinical care standard 4. Current international guidelines refer to 'on admission', and the Saudi clinical expert group agreed that the screening should be carried out as part of the routine admission process. Therefore, the standard was not changed.

The data collectors and teams pointed out that families were not always available to be with patients for education about their conditions, particularly when the patients are expatriates, and during COVID-related restrictions on visiting patients in hospitals. This situation was acknowledged by adding exceptions to the clinical care standards and the data collection process.

Response to the clinical audit methodology

The integrity of the scientifically sound clinical audit methodology providing clinically valid measures and reliable data, based on well-defined clinical audit practice [19], was recognized by the hospital teams. No negative feedback about the technical design or conduct of any of the clinical audits was received by any of the clinical teams in any of the 16 participating MoH hospitals.

Reliability of data collected

The findings of data validation overall ranged from 54.9% to 100.0%. After discussion between hospital data collectors and the independent data validators, the findings of data validation across all four audits ranged from 94.1% to 100.0%.

Hospitals' compliance with the clinical care standards

Across the four clinical audits, compliance with the clinical care standards showed improvement between the first and second rounds of data collection. For 34 (40.5%) of the 84 quality-of-care measures used to measure compliance with the 52 standards, the degree of improvement was statistically significant at the 0.05 level. Table 2 shows the overall performance for each of the audits.

Variation among hospitals

Hospitals varied in their responsiveness to the data from the initial round of data collection. Although all teams submitted improvement plans for the audits they participated in, some hospitals were more successful than others in fully implementing their improvement plans and having the effects of actions reflected in significant improvements in the data in the repeat data collection cycle.

Variation in improvement by standard

Data showing initial and follow-up compliance with each clinical care standard for each audit are provided in Supplementary Material.

The Emergency Medical Service (EMS) for patients in the audits is provided by Red Crescent, an authority independent of the MoH. Red Crescent senior management were informed about the audits and asked for the findings of initial data collection for the audits that involved transport of emergency patients to a hospital. The data collected on the follow-up showed improvements in several aspects of EMS performance, although not all the improvements were statistically significant.

Generally, the standards for which improvement was statistically significant were the standards that teams

Table 2. Overall improvement in compliance across the participating hospitals for four national clinical audits.

		Myocardial infarction				Total	
Audit subject and number of quality-of-care measures	Major trauma (16)	STEMI (18)	NSTEMI (13)	Sepsis (11)	Stroke (26)	(84)	100%
Number of measures for which improvement was statistically significant	7	9	1	4	13	34	40.5
Number of measures for which improvement was achieved but not statistically significant	6	0	6	4	8	24	28.6
Number of measures for which there was essentially no change in performance[a]	2	5	2	3	4	16	19.0
Number of measures for which performance was worse between first and second rounds of data collection	1	1	3	0	1	6	7.1
Number of measures for which compliance could not be calculated because dates and times were not documented in patient records	0	3	1	0	0	4	4.8

[a]Defined as a difference of 3.5% or less.

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working in their own hospitals could act on successfully in a short time frame because the aspects of care referred to were carried out by the staff themselves. Examples are in Table 3.

Other aspects of care referred to in the clinical care standards were dependent on changes in the availability of clinical staff resources or in systems supporting MoH hospitals, such as supply chains. For example, assessments for rehabilitation for major trauma, myocardial infarction, and stroke patients are dependent on having a rehabilitation team of appropriate specialist staff available in the hospitals. Major trauma patients with long bone fractures having fixation and soft tissue cover within 72 hours depend on the availability of orthopaedic surgeons and systems for allocating their workloads. High-sensitivity cardiac troponin tests were not used by NSTEMI patients in some emergency departments because the tests are not continuously available, resulting in potentially unnecessary hospital admissions and delays in diagnosis.

Discussion

Statement of principal findings

Four national clinical audits carried out in 16 MoH hospitals in Saudi Arabia demonstrated that it is possible to conduct clinical audits on key clinical subjects in these hospitals. The teams assigned to be responsible for the clinical audits in their hospitals embraced the clinical audit process and acted to make improvements in the quality of patient care that were within the authority of the teams to do. The audits also revealed shortcomings in patient care for which the causes are attributable to systems and resource issues that are outside the authority of clinical teams to act on.

Strengths and limitations

Several factors appear to have contributed to the success of these national clinical audits. Leadership, support, and governance of the conduct of all stages of the audits were effectively provided by the CEGD in the MoH, in accordance with published standards [10]. Governance included involving key stakeholders in the project, including key staff in the MoH and representatives of the Health Holding Company, the Center for National Health Insurance, and the management teams in the Clusters in which the participating hospitals were located.

Unlike the Cochrane review on 'audit and feedback' which focuses on mechanisms for providing feedback to practitioners following data collection [20], this project combined traditional clinical audit with a quality improvement approach. The clinical audit process did not 'stop' with providing feedback to the participating hospitals but went on to help teams proactively with making improvements in patient care. 'Improving quality requires a broader perspective than a model focused exclusively on decision-making by individual clinicians at the point of care,' and '… typically draws on disciplines such as human factors engineering, operations management and behaviour economics' [21].

The major limitation of this work is that the project included only 16 hospitals and the hospitals tended to be large, well-established hospitals and believed to be leading hospitals in the MoH. Because of time constraints imposed by the project, the number of patients included in each cycle of data collection was reasonably small, particularly for the repeat data collection cycle. Also, the teams had only 4 months to plan and implement their actions to produce improvements in the quality of patient care.

All interactions with everyone participating in the project, including the Saudi clinical expert groups, teams in each hospital, data collectors, and MoH staff associated with the project, had to be carried out online because of the travel restrictions associated with the COVID-19 pandemic. Although unexpected and unplanned, the online approach worked well because of convenience to clinical staff.

The organizational mechanisms for implementing systems and resource allocation changes in MoH hospitals are in transition through the transformation to implement Vision 2030. Although the roles of the MoH, Health Holding Company, and Center for National Health Insurance are known, it will take some time for the new organizational arrangements to be uniformly effective in implementation of changes in previously well-established organizational systems. In the meantime, responsibility and accountability for acting on evidence related to clinical practice through clinical governance was not well understood at all levels in the MoH, which may have contributed to lack of action on the systems issues identified.

The challenge is the extension of this project to other MoH hospitals and to other hospitals in Saudi Arabia. Much of the data needed to measure compliance with the clinical care standards are not routinely captured in electronic record systems and had to be retrieved from paper records. Trained data collection staff need to be available for the clinical audit data collection. Staff involved in collecting data faced competing priorities with retrieving information for national key performance indicators also required by the MoH.

Interpretation within the context of the wider literature

Researchers refer to a 'theory of change for improvement', which involves identifying a range of types of changes needed to achieve the improvement intended, for example, improved compliance with established criteria or standards used in a clinical audit [22–25]. The theory of change is more encompassing than a theory of feedback with as many as 25 factors having been identified as influencing the achievement of improvement of the quality of patient care [26]. The range of changes to improve the quality of patient care was demonstrated in the projects.

Implications for policy, practice, and research

The mandate of having a multiprofessional team assigned to be responsible for each audit in each participating hospital recognized that patient care is provided by teams of professionals not only by doctors. Several studies [27–29] support the use of teams, especially multiprofessional teams, in delivering improvements in the quality of patient care. The teams involved in the audits, especially the doctors in the teams, acknowledged the impact of nurses on stroke patients' outcomes; the role of pharmacists in supporting patient compliance with medications; the criticality of availability of rehabilitation specialists to the outcomes of patients with trauma, myocardial infarction, and stroke; and the substantial contribution of health educators to patients with the diagnoses included in the audits.

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Table 3. Examples of statistically significant improvements in compliance with clinical care standards.

Clinical care standard	Initial	Follow-up	*P* value
Major trauma			
A trauma team leader is available to meet a major trauma patient at the time of the trauma patient's arrival	69.5%	94.3%	<.00001
A major trauma patient receives pain relief	34.4%	93.1%	<.00001
The major trauma patient record is complete	23.7%	58.6%	<.00001
There is a documented handover when the major trauma patient is handed over to another department or service	74.8%	94.3%	.0002
A major trauma patient is informed about injuries, management, and outcomes	51.9%	69.0%	.01242
A major trauma patient eligible for rehabilitation has a documented rehabilitation plan	32.8%	56.0%	.01314
The trauma centre or trauma unit has a massive transfusion protocol	67.2%	97.7%	<.00001
Myocardial infarction—ST-segment elevated MI			
An MI patient transported by EMS had a (i) clinical assessment and (ii) 12-lead electrocardiogram (ECG) within 10 minutes of arrival time	0.0%	7.4%	.00854
A patient was given aspirin by EMS when the ECG confirmed an STEMI	2.2%	22.2%	.00008
For a patient transported to a cardiac cath facility, EMS notified the facility that the patient was en route	4.4%	27.8%	<.00001
If a person with chest pain arrives at a hospital's Emergency Department (ED), ED staff carry out a (i) clinical assessment and (ii) 12-lead ECG within 10 minutes of arrival	27.9%	53.0%	.00188
An MI patient is screened on admission for diabetes using an HbA1c test	57.1%	82.8%	<.00001
An MI patient with left ventricular function (LVF) ≤40% is prescribed an angiotensin-converting enzyme inhibitor or an angiotensin receptor blocker, a beta blocker, and a mineralocorticoid/aldosterone receptor blocker, unless the patient has a contraindication	52.1%	82.0%	.0003
An MI patient is referred to a cardiac rehabilitation program	5.6%	37.3%	<.00001
An MI patient referred to cardiac rehabilitation has an assessment appointment within 10 days of discharge from the hospital	0.0%	82.2%	<.00001
An MI patient, and his or her family if available, receives education about MI and heart attack prevention before the patient is discharged from the hospital	62.7%	97.0%	<.00001
Myocardial infarction—non–ST-segment elevated MI			
An MI patient, and his or her family if available, receives education about MI and heart attack prevention before the patient is discharged from the hospital	49.3%	69.0%	.01278
Sepsis			
A patient with suspected sepsis has all of the following recorded on arrival in the emergency department (record entries listed)	62.1%	78.1%	.00338
A patient with suspected sepsis has an intravenous (IV) line inserted as soon as possible within the first hour of sepsis being identified	68.0%	97.2%	<.00001
A patient with suspected sepsis has an intravenous antibiotic administered as soon as practicable after the IV line is inserted within the first hour of sepsis being identified	57.6%	73.7%	.00438
The specialist who is assuming responsibility for the sepsis patient's admission admits the patient within 1 hour of the consultation in the emergency department	12.2%	34.6%	<.00001
Stroke			
The EMS notifies the hospital of the incoming suspected acute stroke patient	12.0%	45.7%	<.00001
The EMS provides clinical information about the patient en route to or on arrival at the hospital	0.0%	7.1%	.01314
The patient is assessed using the National Institutes of Health Stroke Scale NIHSS	25.7%	42.7%	.00034
The patient has a swallow screen within 4 hours of the patient's arrival to the hospital	3.9%	27.1%	<.00001
The patient is not given any oral food or fluid or medication in the absence of a swallow screen within 4 hours of the patient's arrival to the hospital	3.9%	34.4%	<.00001
The patient is admitted to the specialist stroke unit in the hospital	61.8%	72.6%	.0466
The patient has his or her blood glucose level measured in the admitting unit as follows: (i) on admission to the stroke unit and (ii) 4 times a day on Day 1 and (iii) 4 times a day on Day 2	20.9%	30.7%	.02444
The patient has his or her temperature measured and recorded for the first 72 hours following admission as follows: (i) on admission to the stroke unit and (ii) 4 times a day on Day 1 and (iii) 4 times a day on Day 2 and (iv) 4 times a day on Day 3	59.2%	72.9%	.00398
A patient who has had an ischaemic stroke is given aspirin and clopidogrel: (i) within 24 hours of symptom onset and (ii) prescribed for 21 days	67.8%	82.0%	.00328
The patient has a risk assessment for venous thromboembolism within 24 hours of admission	96.1%	99.5%	.02444
The patient has his or her needs for rehabilitation assessed within 24 to 48 hours of admission	34.0%	59.9%	<.00001
The patient has a documented rehabilitation plan	46.1%	57.8%	.0198
The patient and his or her family, if available, receive education about stroke and stroke prevention before the patient is discharged from the hospital	44.7%	62.0%	.00054

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A practical number of clinical care standards, supported by Saudi and international experts, to be implemented (11 to 15) for each subject, focused on those aspects of care that are known from the evidence base to have a positive effect on patient outcomes. Having a limited number of clinical care standards contributed to manageable data collection and to supporting the provision of value-based care. The national clinical audit programme in the UK is working to make the UK programme more effective at supporting improvement in patient outcomes. Reducing the number of measures in each audit to 10 is one of the changes being introduced into national clinical audits in the UK [30]. Other changes are related to the nature and timeliness of reports on the audits and more emphasis on patient outcomes. The MoH audit project had already applied these principles.

Finally, continuous technical support and communication with all teams and all data collectors in all the hospitals by both the project and MoH staff made an important contribution.

Conclusions

This project of four national clinical audits carried out in 16 hospitals in the MoH in Saudi Arabia demonstrated that multiprofessional clinical teams in the hospitals could work together to produce improvements in the quality of their patient care. Leadership, stakeholder engagement, a quality improvement approach, multiprofessional team involvement, technical support for the work, and governance contributed substantially to the success of the project as did the scientifically sound approach to carrying out all the stages in the clinical audit process. The project approach adds to the currently limited evidence on the effectiveness of clinical audits in achieving improvements in clinical quality. The approach can be replicated in Saudi Arabia and in other national clinical audit programmes.

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The MoH hospitals participating in the major trauma national clinical audit were King Salman Hospital, Al Iman Hospital, and King Saud Medical City, all in Riyadh Cluster One; Prince Mohamed Bin Abdulaziz Hospital in Riyadh Cluster Two; and Al Qatif Central Hospital in Eastern Cluster One. The hospitals participating in the myocardial infarction national clinical audit were King Saud Medical City in Riyadh Cluster One; King Fahad Medical City in Riyadh Cluster Two; Prince Sultan Cardiac Center in Buraidah in Al Qassim Cluster; Prince Sultan Cardiac Center in Hofuf in Al Ahsa Cluster; and Saud Al-Babtain Cardiac Center in Eastern Health Cluster One. The hospitals participating in the sepsis national clinical audit were Imam Abdulrahman Alfaisal Hospital and King Khalid Hospital in Al Kharj in Riyadh Cluster One; Prince Mohamed Bin Abdulaziz Hospital in Riyadh Cluster Two; Dammam Medical Complex and Al Qatif Central Hospital in Eastern Cluster One. The hospitals participating in the stroke national clinical audit were King Saud Medical City in Riyadh Cluster One; King Fahad Medical City and Prince Mohammed Bin Abdulaziz Hospital in Riyadh Cluster Two; and Dammam Medical Complex and Al Qatif Central Hospital in Eastern Cluster One.

Dr Abdulrahman Alqahtani of the Health Holding Company and Dr Abdulaziz Alrabiah and Sofia Macedo of the Center for National Health Insurance reviewed the data from the first round of data collection for the audits.

Dr Ahmed Safwat reviewed draft documents produced for the project, and Reem Banaja managed the contract work on behalf of the Saudi sponsoring organization. Fawziah Alowayyid and Diaa Samir were Saudi Arabia-based project managers who maintained continuous liaison with all the hospitals and carried out all the data reliability and validation checks in every hospital.

Author contributions

S.A. directed and managed the entire national clinical audit programme and recruited the participating hospitals, on behalf of the Saudi Arabian MoH. N.D. carried out the detailed analyses of the international guidelines, developed

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the clinical care standards with Saudi and international clinical experts, designed the clinical audits in detail, led all the workshops with clinical teams, wrote all the project reports, and drafted this article. Elizabeth Cox reviewed all the clinical audit designs and data collection instructions and training materials, managed the entire data collection process with the participating hospitals, provided all analyses of the data, and contributed to all project reports. The additional authors led the Saudi clinical expert groups that developed the clinical care standards and the clinical audit designs.

Supplementary data

Supplementary data is available at *IJQHC* online.

Conflict of interest statement

N.D. and Elizabeth Cox are employed by Healthcare Quality Quest, the international partner in the contract with the MoH to execute this project.

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Data availability

Data were collected via a standardized data collection questionnaire to be completed for each patient in each audit in each of the two rounds of data collection. Apart from demographic data about the patient, the questions in the questionnaire were typically answered yes or no to indicate whether or not the patient's care was consistent with the clinical care standards. Data reported to the participating hospitals and the MoH were in the form of the numbers and percentages of patients in each clinical audit whose care is consistent with each clinical care standard by participating hospital and overall across all hospitals. Summary data for each clinical audit are provided in the Supplementary Material. All data collected in both rounds of data collection for the clinical audits, with individual hospitals not identified, are available from the authors, with the permission of the MoH.

Ethics and other permissions

The clinical audit designs were screened by the CEGD for any ethical issues prior to the start of data collection for each audit, using a checklist derived from the evidence base, and it was determined that there were no ethical issues associated with the clinical audits. It was deemed by the CEGD in the MoH and the Health Holding Company, the funding organization, that there were no ethical issues associated with the project.

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