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Ng, C. J., Andrew, P., Crawley, M., Pevreal, W., & Peach, J. (2016). Assessing a hospital medication system for patient safety: Findings and lessons learnt from trialling an Australian modified tool at Waitemata District Health Board. *New Zealand Medical Journal*, 129(1430), 63-77. Retrieved from <https://www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2016/vol-129-no-1430-19-february-2016/6816>

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Assessing a hospital medication system for patient safety: findings and lessons learnt from trialling an Australian modified tool at Waitemata District Health Board

Jerome Ng, Penny Andrew, Marilyn Crawley, Wynn Pevreal, Jocelyn Peach

ABSTRACT

AIM: To undertake a review of Waitemata District Health Board's (WDHB) hospital medication system for patient safety assessment and improvement purposes.

METHODS: A multidisciplinary group rated current WDHB hospital medication systems against the Medication Safety Self-Assessment for Australian Hospitals (MSSA[®]-AH) criterion of 247 aspirational practices using a five point scale ("no" to "fully implemented"). Items with a lesser extent of implementation represented practice gaps. The MSSA[®]-AH database and weighted adjustment scoring system generated an overall hospital score.

RESULTS: Of the maximum possible score that could be obtained had all MSSA[®]-AH practices been implemented, WDHB scored 63% and this was comparable to other demographically similar hospitals in Australia. Lowest scoring practices needing improvement related to staffing. Conflict resolution was a previously unidentified practice gap. Previously identified gaps, such as those relating to electronic medication systems suggested ongoing implementation was required.

CONCLUSION: This was the first documented use of the MSSA[®]-AH's in a New Zealand hospital setting and helped WDHB identify areas in need of further improvement. The unique generation of a percentage score helped simplify understanding for non-technical stakeholders. Future repeated assessments would help WDHB track progress. Implicit benefits, such as stakeholder engagement, were observed. The MSSA[®]-AH may be useful in other hospital settings.

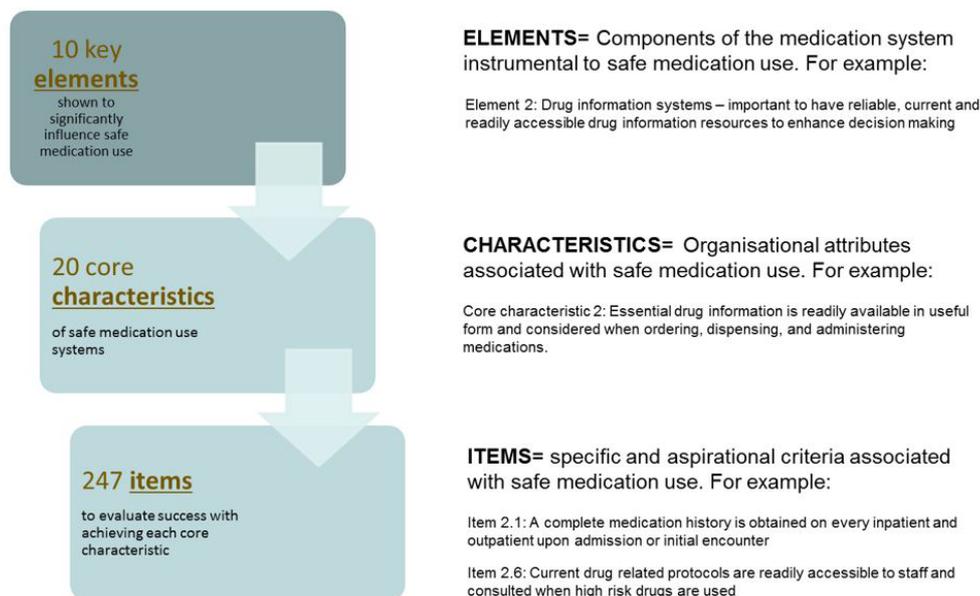
Medicines are the most common medical interventions used in healthcare. Of all unintended injuries caused by medical management, the largest proportion relate to medications.¹ Injuries resulting from the wrong medicine or dose being given could have been prevented through safer medication practices.¹⁻³ Medication safety practices, such as the implementation of electronic prescribing and administration with clinical decision support (ePA), or clinical pharmacy involvement in medical care, can help

reduce medication errors and harm.⁴⁻⁸ The enhancement of medication systems is fundamental for any organisation committed to making their hospitals safer for patients.¹

Standards to help hospitals assure medication systems for patient safety, such as those set by Medsafe and the Health and Disability Services (NZS8134.1:2008), have been used as part of certification for a number of years in New Zealand.^{9,10} An important but commonly missed point, however, is that standards only provide minimum acceptable levels of practice. In

Figure 1: Medication Safety Self-Assessment for Hospitals® criteria components, their meaning and examples.

MSSA-AH® criteria components and what it means



contrast, assessing a hospital's medication system against an aspirational criterion of ideal medication safety practices can help identify potential gaps for further enhancement.¹¹

A widely endorsed tool to assess medication systems has been the Medication Safety Self-Assessment for Hospitals (MSSA®).¹¹⁻²² Consistent with current professional knowledge and evidence, the MSSA® and its modified version for Australian Hospitals (MSSA®-AH), contains a criteria list of 247 items of ideal and aspirational medication safety practices. The MSSA®-AH has apparent good face and construct validity having been tested across several Australian hospitals and promoted for use by the Australian Quality and Safety Commission.²³ Despite international widespread use, no published research of MSSA®-AH use in New Zealand was identified.^{11,15,16}

Waitemata District Health Board (WDHB) comprises several large healthcare facilities, of which North Shore (595 beds) and Waitakere (269 beds) are its largest hospitals. WDHB's promise to its community is best care for everyone. It aims to provide healthcare that is safe, continuously improving and among the best

in the world. To help fulfil WDHB's promise, a systematic assessment of hospital medication systems was needed to inform how safe systems were, identify areas for further improvement, track and demonstrate progress over time.

With a view to determine the utility of the MSSA-AH® for New Zealand hospital settings, and obtain specific information for WDHB purposes, an assessment of local hospital medication systems using the tool was undertaken. The findings obtained will be described for illustrative purposes, and the utility of the tool for WDHB explored. Lessons learnt, limitations and implications of the findings on New Zealand policy, practice and research will be discussed.

Method

After consultation with the Institute for Safe Medication Practice (ISMP), and due to perceived similarities between New Zealand and Australian hospital systems, the Clinical Excellence Commission's (CEC) MSSA®-AH version was selected for use. Permission for the use of the CEC electronic database was obtained and a nominal subscription fee paid. No commercially sensitive or patient information was collected, and thus

Table 1: Demographic information of Waitemata DHB using the MSSA®-AH categories.

Demographic information categories listed in the MSSA®-AH	Waitemata DHB demographic information
Number of inpatient beds	More than 500 beds
Type of organisation for establishing policy for the overall operation of hospital	Public sector
Best description of service that the hospital provides to the majority of its admissions	General medical and surgical
Specific services provided at the hospital as defined within the MSSA®-AH	Oncology, Paediatrics, Neonatal intensive care unit, trauma services, maternity, psychiatric, Ear Nose and Throat (ENT) and Ophthalmology
No. of hospitals comprised within a larger healthcare organisation with common ownership and/or governance	Two to five hospitals (ie, North Shore and Waitakere)
Location of hospital(s)	Metropolitan
Pharmacy services management	Internally
Clinical pharmacy services availability	Yes
State or territory hospital is located	New Zealand

was not deemed to be an organisational or privacy risk. A review of WDHB's medication systems using the MSSA-AH® tool for patient safety was sought and endorsed by WDHB's medication safety group (MSG) in late 2014. MSSA®-AH instructions recommend the assessment of one hospital at a time.¹² The differences in medication systems at both North Shore and Waitakere were deemed negligible by members of the MSG group and so a decision was made to review the entire WDHB.

The instructions for conducting the review and methodology behind the MSSA® tools have been described in-depth elsewhere,¹¹⁻¹³ so a brief outline is provided. The MSSA®-AH comprised 247 medication safety practice items which can be grouped into 20 core characteristics and 10 key elements (see Figure 1). Items referred to medication safety practices. Characteristics referred to organisational attributes associated with safe medication use (see Appendix 3 for the list and their explanations). Elements referred to components of the medication use system instrumental to safe medication use (see Appendix 2).

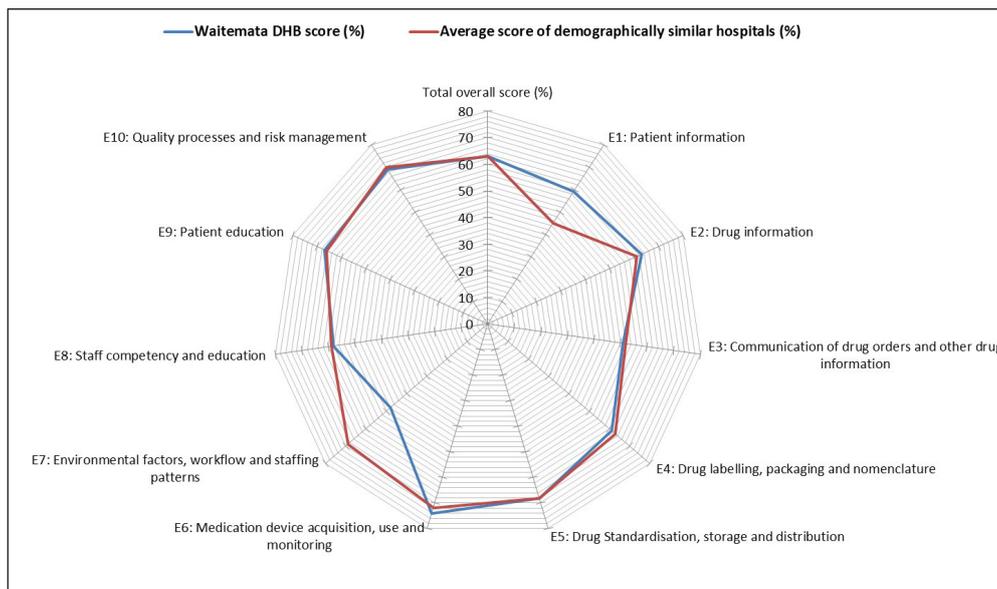
Each item in the MSSA®-AH had a maximum possible weighted score based on their impact on medication safety. The maximum possible weighted scores for each item were 16 (highest impact), 12, 8, 4 or 2 (lowest impact). Items with the heaviest weighting were those which have demon-

strated long-lasting effectiveness in reducing serious medication errors, that target the system and not just the workforce and which safeguard high-risk patient groups.¹²

In accordance with MSSA®-AH instructions, a multi-disciplinary medication safety review (MSR) group representing those with intimate knowledge of WDHB's medication systems were purposively selected to undertake the review (see Appendix 1). A team leader was responsible for coordinating the review. MSR members were not aware of the weighting for each item when completing the assessment. MSR members considered current WDHB practice and rated the extent of implementation of each aspirational item using a five point scale ("no" to "fully implemented").

Items with less extensive implementation represented practice gaps and scored the lowest, while items with a greater extent of implementation scored the highest. When consensus of the MSR group was reached for the item's rating, the result was recorded on paper by the team leader. As part of the initial briefing, participants were reminded that this was a formative exercise aimed at better understanding of existing gaps in practice. Where there were different opinions about the level of implementation for a certain item, the most conservative rating score was selected. Field notes on the relevance and limitations of particular items in local settings,

Figure 2: MSSA-AH® scores (%) across each of the 10 key elements safe medication use for Waitemata DHB compared with demographically similar hospitals across Australia (n=24 hospitals).



suggestions or comments were also captured to help inform the refinement of the tool for future and New Zealand specific use. In total, the MSR group met once weekly for three consecutive weeks, with each meeting taking 90 minutes.

At the completion of assessing all MSSA®-AH items, the data was entered into the CEC secure and confidential online electronic database. Rated scores for each item and the overall hospital were calculated as a percentage of the total possible maximum weighted scores. The MSSA®-AH database and weighted adjustment scoring system automatically generated WDHB's result. To help prioritise the 247 items for improvement, the results generated from the CEC database was exported to Microsoft Excel 2010. Items were then ranked according to:

1. Weighted scores, which represented the item's impact on medication safety (from highest to lowest impact in descending order), then by;
2. Items with the largest gap in score between the maximum possible score and actual score (from largest to lowest gap in descending order), then by;
3. Items specifically flagged by MSR members as being important to WDHB for improvement.

The ranked items provided a basic framework for discussion and theme generation. Using a general inductive approach, each item was further coded and categorised according to the common subject theme.^{24,25}

Item 9.2, for example, was "Doctors and other prescribers routinely educate patients about recommended drugs before initial dose received", and was rated a "C" (partially implemented) by the MSR group. Item 9.2 was categorised under the subject label of "patient education" and this represented an area for further improvement because it was not fully implemented. Emergent key themes were presented to the MSG for the consideration of impact, difficulty in implementation and priority for improvement at WDHB.

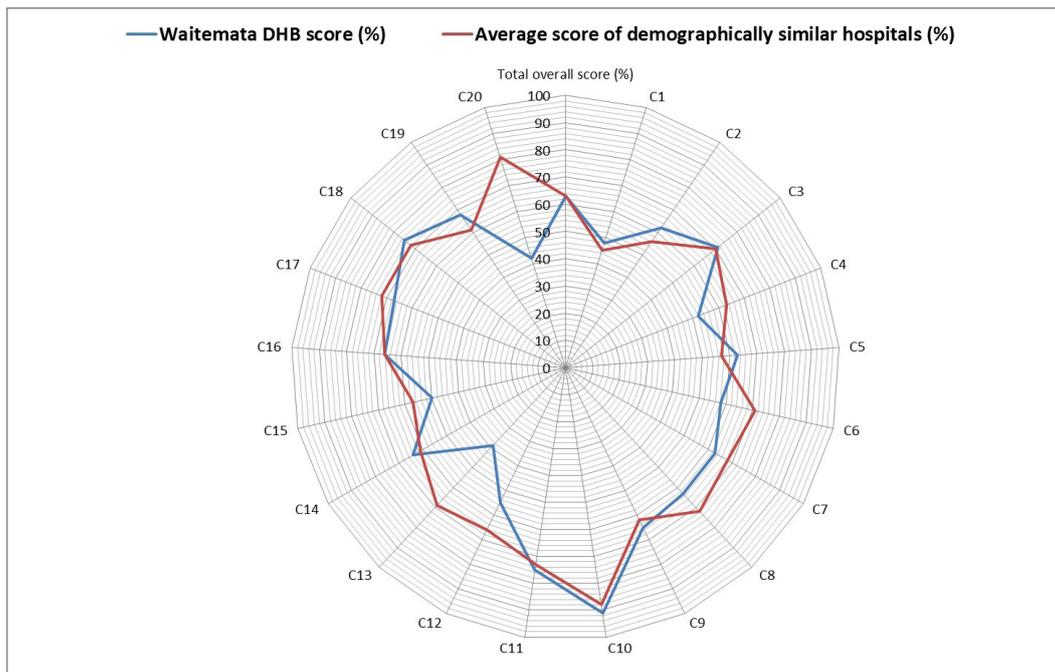
Results

Waitemata DHB's demographic information has been outlined in Table 1.

In Australia, a total of 370 hospitals have used the MSSA®-AH tool. Using the MSSA®-AH criteria listed in Table 1, 24 Australian hospitals were categorised as being demographically similar to WDHB, and the results from these hospitals formed the basis for comparison. The results were analysed according to the 10 key elements and graphically displayed in Figure 2.

The radar chart in Figure 2 provides WDHB's self-assessed score against each of the ten key elements of the MSSA®-AH. WDHB scores have been expressed as a percentage of the total maximum possible score for each of the ten key elements. Of the maximum possible score that could be obtained through the full implementation of all medication safety practices listed in the MSSA®-AH, WDHB's overall score was 63%. WDHB's

Figure 3: MSSA-AH® scores (%) across each of the 20 core characteristics of safe medication use for Waitemata DHB compared with demographically similar hospitals across Australia (n=24 hospitals).



Legend

C1: Essential patient information is obtained, readily available in a useful form and considered when prescribing, dispensing and administering medication.

C2: Essential drug information is readily available in useful form and is considered when prescribing, dispensing, and administering medications.

C3: A controlled drug formulary system is established to limit choice to essential drugs, minimise the number of drugs with which PRACTITIONERS must be familiar and provide adequate time for designing safe processes for the use of new drugs added to the formulary.

C4: Methods of communicating drug orders and other drug information are standardised and automated to minimise the risk of error.

C5: Strategies are undertaken to minimise the possibility of errors with drug products that have similar or confusing manufacturer labelling/ packaging and/or drug names that look and/or sound alike.

C6: Readable labels that clearly identify drugs are on all drug containers and drugs remain labelled up to the point of actual drug administration.

C7: IV solutions, drug concentrations, doses and administration times are

standardised whenever possible.

C8: Medications are provided to patient care units in a safe and secure manner and available for administration within a timeframe that meets essential patient needs.

C9: Unit-based ward or imprest stock is restricted.

C10: Hazardous chemicals are safely sequestered from patients and not accessible in drug preparation areas.

C11: The potential for human error is mitigated through careful procurement, maintenance, use and standardisation of devices used to prepare and deliver medications.

C12: Medications are prescribed, prepared, dispensed and administered in a physical environment that offers adequate space and lighting and allows PRACTITIONERS to remain focused on medication use without distractions.

C13: The complement of qualified, well-rested PRACTITIONERS matches the clinical workload without compromising patient safety.

C14: PRACTITIONERS receive sufficient orientation to medication use and undergo baseline and annual competency evaluation of knowledge and skills related to safe medication practices.

C15: PRACTITIONERS involved in medication use are provided with ongoing education about medication error prevention and the safe use of drugs that have the greatest potential to cause harm if misused.

C16: Patients and/or their parents/ carers are included as active partners in their care through education about their medications and ways to avert errors.

C17: A non-punitive, systems-based approach to error reduction is in place and supported by management, senior administration, and the Governing Body.

C18: PRACTITIONERS are stimulated to detect and report errors, and multidisciplinary teams regularly analyse errors that have occurred within the organisation and in other organisations for the purpose of redesigning systems to best support safe PRACTITIONER performance.

C19: Simple redundancies that support a system of INDEPENDENT DOUBLE CHECKS or an automated verification process are used for vulnerable parts of the medication system to detect and correct serious errors before they reach patients.

C20: Proven infection control practices are followed when storing, preparing and administering medications.

Table 2: Top 10 key themes for medication safety improvement at Waitemata DHB based on MSSA@-AH tool weighted scores, practice gaps and perceived priority areas by the Medication Safety Review (MSR) team.

Priority themes for medication safety improvement at Waitemata DHB and MSSA-AH® items as targets for implementation related to the following areas:	
1. Electronic and automated medication systems	<ul style="list-style-type: none"> Item 3.2A: ePA system warns prescribers about unsafe orders (eg, overdoses, interactions) and guides appropriate use. Item 3.1: ePA directly interfaced with pharmacy computer system. Item 1.17: ePA directly interfaced with lab system to guide appropriate prescribing. Item 2.16: All inpatient prescriptions are screened for appropriateness before being administered. Item 3.9: ePA system shares a common database with pharmacy to facilitate drug administration. Item 1.14: Barcoding is used to verify patient identity during drug administration. Item 10.44: Barcoding used to verify correct drug administered. Item 10.42: Barcoding used to verify drug picked for dispensing. Item 6.13: Infusor pumps with clinical decision support are in use with full functionality.
2. Staff shortages and high workload	<ul style="list-style-type: none"> Item 2.11: Pharmacists regularly work directly in outpatient care units. Item 2.9: Pharmacists regularly work directly in inpatient care units. Item 7.12: Contingency plan established when short staffed. Item 7.13: Pharmacy perceives staff shortages pose a risk to providing safe pharmaceutical care. Item 8.8: Staff are not pulled from their usual areas without adequate training and orientation. Item 7.11: Schedules and workload permit staff to take at least one 15-minute break and one 30-minute break per shift (NB: focused on medical doctors).
3. Medication safety measurement and surveillance system	<ul style="list-style-type: none"> Item 10.24: e-triggers are used to enhance detection of potential adverse drug events (ADE). Item 10.1: One or more staff dedicated to enhance detection of medication errors, oversee analysis of their causes, and coordinate an effective error reduction plan. Item 10.29: med safety measurement and surveillance system in place (past, present, future).
4. Patient safety and learning culture with communication	<ul style="list-style-type: none"> Item 8.16: Staff regularly receive information about medication errors and high risk situations. Item 10.3: All known med errors disclosed to patient and families. Item 10.23: MDT routinely analyses errors to proactively target areas for improvement. Item 10.4: no disciplinary action against slip/lapse errors. Item 3.11: conflict resolution policy and pathway when pharmacist and nurse safety concerns differ to those by prescribers. Item 10.2: Staff report and openly discuss errors without fear of reprisal from hospital. Item 10.22: "Near misses" are given the same high priority for analysis and error prevention strategies as errors that actually cause harm. Item 10.30: Strategies are in place to allow staff, regardless of rank, to raise concern without fear or intimidation.
5. High-risk drugs (IV) to be independently double checked and unit dose	<ul style="list-style-type: none"> Item 5.20: 1st dose of high-alert drugs reviewed by pharmacist before being available. Item 6.4: Every new change or infusion of high alert drugs in paediatric patients is independently checked before use. Item 4.14: Labelled, ready-to-use unit doses dispensed.
6. Standardised insulin sliding scale	<ul style="list-style-type: none"> Item 5.7B: Standardised sliding scale protocol in place (alternative is to NOT use sliding scale).
7. Environment and equipment supporting drug administration	<ul style="list-style-type: none"> Item 5.6: Dosing windows established to help nurses safely administer most medications at established standard times. Item 6.3: All tubing for admin lines are labelled adjacent to the injection port(s). Item 7.3: Pharmacies and ward medication rooms have adequate space for storage of drugs. Item 7.4: IV preparation area is isolated to minimise distractions. Item 7.7: Nurses select meds for admin in areas relatively free of distractions and noises.
8. Organisational wide plans and downstream effects communication and consideration	<ul style="list-style-type: none"> Item 7.16: Hospital plans are well communicated to affected staff and downstream effects considered. Item 10.11: Specific med safety objectives are included in the hospital strategic plans and celebrated when met.
9. Patient education	<ul style="list-style-type: none"> Item 9.2: Doctors and other prescribers routinely educate patients about recommended drug before initial dose received.
10. Analgesia and sedation complications monitoring and management	<ul style="list-style-type: none"> Item 1.13: Monitoring of analgesia complications. Item 5.13: Antidotes (for opioids, sedatives) and guidelines for emergency use readily available near point of use.

score was the same as other demographically similar Australian hospitals (63%).

Of note, WDHB self-assessed to have implemented more extensively than other Australian hospitals medication safety practices related to patient information (ie, Element 1: 59% vs 45%). However, medication safety practices related to environmental factors, workflow and staffing patterns were self-assessed to have been less extensively implemented compared with other similar Australian hospitals (ie, Element 7: 48% vs 69%) and this represents a gap for improvement for WDHB.

WDHB scores analysed by the core characteristics of a safe medication system were graphically presented in Figure 3.

Compared with other Australian hospitals, WDHB self-assessed to have implemented to a similar extent many medication safety practices and characteristics. Core characteristics where WDHB self-assessed to not have implemented medication safety practices as extensively as other hospitals were C4 (52% vs 63%), C6 (58% vs 71%), C12 (55% vs 66%), C13 (39% vs 63%) and C20 (42% vs 81%). The themes of these relate to “medication order communication”, “better labelling of medicines”, “the provision of distraction free physical environments where medicines are used”, and “staffing and workload” issues, respectively.

The key themes of identified gaps for improvement at WDHB are outlined in Table 2. Of the highest impact medication safety practices, the most common theme identified for improvement related to “electronic and automated medication systems”. Specific items relating to electronic systems which were highly ranked are listed in Table 2 as examples of areas for further implementation. Consistent with the analysis using the elements and core characteristics in and respectively, “staffing and workload” issues appeared to be a key area for improvement. The themes of medication safety practices requiring further implementation at WDHB related to “medication safety measurement and surveillance system”, “high risk drugs which are independently double checked” and “patient safety learning and communication”.

Discussion

Benefits obtained from the use of MSSA®-AH

The information obtained from, and the process of, assessment using the MSSA®-AH was meaningful for WDHB for a number of reasons. Firstly, previously unidentified medication safety practice gaps were discovered and highlighted areas for intervention. For example, it was identified that WDHB did not have a formal process “that can be followed by nurses and pharmacists to resolve conflict when prescribers do not agree with their expressed concerns about the safety of an order” (Item 3.11).¹⁷ Disrespectful behaviours towards staff who question the safety of an order may lead to unsafe medications being administered to the patient.²⁶ Interventions, such as the development of a formalised escalation pathway coupled with behaviour change management, may thus help resolve such conflicts and prevent unsafe orders from ever reaching the patient. Practice gaps for improvement will be addressed and incorporated within the WDHB Medication Safety Strategy for action in the 2015–2018 periods.

A second benefit was derived from MSSA®-AH’s weighting system and unique generation of an overall hospital score as a percentage. This helped simplify the complexity of the results and interpret, for non-technical stakeholders, the significance of the findings. Similar to school reports, WDHB’s score of 63%, which could be approximately equated to a C+, resonated with stakeholders as being passable, but further improvement was required. MSSA®-AH scores helped to reinforce engagement among management and senior staff, and continue the support of improvement initiatives. Coupled with the ability to now compare against other hospitals—and for an organisation which aims to provide care that is among the best in the world—the results promulgated the need for further improvement. Having established baseline scores for the overall system and individual items, WDHB can now track its progress over time with repeated assessment.

Beyond the utility of the information obtained for measurement purposes, a third, and arguably most important observed benefit, was the generation of engagement from undertaking the assessment process and the nurturing of a shared belief in the importance of patient safety. Applying the MSSA®-AH forced staff to critically reflect on existing medication systems, whether in a ward, hospital or entire organisation, for patient safety and motivated individual action and system development in their respective areas to support and inform priorities. Research previously published in this journal suggests many patients admitted into New Zealand hospitals are inadvertently harmed by the medications intended to help them, and this emphasises the importance of conducting assessments such as the MSSA®-AH to help evaluate progress and further improve medication safety practices.^{27,28}

Limitations and lessons learnt for future MSSA®-AH use

Some of the recommended practices within the MSSA®-AH have strong evidence supporting their implementation to reduce errors and harm, but many do not.^{4,5} Even if all recommended medication safety practices contained in the MSSA®-AH were implemented, there may be no demonstrable change to adverse medication-related incident trends. Research suggests that medication systems are complex and good systems are not always causally linked to desired health outcomes. In fact, unintended adverse consequences can occur²⁹⁻³³ and there are well-known methodological difficulties in establishing correlation between implemented interventions and improved patient safety outcomes.^{34,35} MSSA®-AH cannot be used in isolation to measure medication safety within a hospital. In order to holistically assess medication safety, other tools and approaches—such as data obtained from trigger tools or observation—need to be used concurrently.³⁶⁻⁴⁰

Recently published evidence suggests that inpatients at hospitals with full quality accreditation were associated with a lower 30-day mortality risk than admissions at partially accredited hospitals.⁴¹ Because many of the recommended practices in the

MSSA®-AH, such as electronic prescribing and barcoding, have been empirically shown to reduce medication errors and harm, high and improving scores may provide a proxy indicator for safe outcomes. Despite apparent good face and construct validity²³ however, no published research was identified which examined the correlation between MSSA®-AH scores with adverse medication incidents. Further research into the association of MSSA®-AH scores with safety outcomes would help determine its suitability as a proxy indicator. At this stage, the MSSA®-AH is probably more useful as a formative indicator of activity, effort and progress for the implementation of safer practices than a definitive and summative measure for improved safety outcomes.

Correspondence with ISMP, and previous publications, suggest that weightings for each medication safety practice item was assigned based on the strength of evidence, sustainability and system effect.^{11,12,42} It is not easily apparent, however, the exact approach on how these weightings were assigned or whether they were applicable for New Zealand settings. Default weighting have been accepted for the purpose of trialling the MSSA-AH® tool in WDHB. Further research into testing the effectiveness of implementing different recommended practices at reducing medication errors and harm in New Zealand hospitals may help to substantiate the content validity of weightings. Qualitative Delphi approaches, by way of expert focus group consensus or questionnaires, may help further assess the face and construct validity of the weightings in the New Zealand setting.

Because the assessment was conducted by staff members, it was important to note the rated scores were subjective and there was the possibility of bias. Bias was possible, but thought to be unlikely. Throughout the assessment process, it could be clearly observed that staff undertook the exercise with a mind-set aimed at learning and improvement. Furthermore, the overall score of 63% suggested that even if bias was present, practice gaps were still being identified for improvement. In-depth investigation into medication-related injuries which occur in the organisation support the practice gaps identified from the MSSA®-AH for improvement.

It is important to note that self-assessment items in the MSSA®-AH tool cover broad concepts, but they do not always detail the exact definition. Take, for example, Item 8.14: “Practitioners are educated about new drugs added to the formulary...” This medication safety practice appears straightforward, logical and common-sense. However, how should the level of education be defined? For an organisation who uses the MSSA®-AH to self-assess, ‘education’ may be interpreted as the development of a newsletter, while for another ‘education’ may refer to one-on-one tutorials with prescribers. Subjectivity in interpretation among assessors may limit the ability to compare MSSA®-AH scores between organisations.

For New Zealand hospital practice requirements, it appeared that the MSSA®-AH can be customised to make it more fit for purpose. For example, questions about the hospital formulary (eg, Item 2.23: “The hospital formulary contains almost no duplication of generic equivalents”), and related questions were less relevant for the New Zealand setting. In New Zealand, there is a national hospital formulary which is managed via the preferred medicines list controlled by PHARMAC; a national government agency for medicines funding.⁴³ Duplicates of generic equivalents are not generally available and individual hospitals have limited control to obtain alternative agents.

Certain weighted scores were difficult to make sense of. For several items where services were not provided at WDHB, the “not-applicable” category was chosen; however, the MSSA®-AH weighting gave such scores a zero. For example, Item 10.47 did not apply because no intravenous admixtures were prepared, but WDHB was scored as zero out of eight. This may have meant that WDHB’s overall score of 63% underestimated the extent of medication safety practices implemented. Several assessment items appeared to be duplicates. For example, Item 1.5 “Prescribers and nurses can easily and electronically access laboratory values for both inpatients and outpatients while working in their respective inpatient and outpatient locations” was similar to Items 1.1 and 1.3, with the only difference being that the

latter items focused on prescribers and nurses individually.

Implications of findings for research, policy and practice

This is the first documented case of MSSA®-AH use in New Zealand hospitals. The findings have significantly added to the body of research on how New Zealand hospital medication systems can be assessed for patient safety. The information obtained from the use of the MSSA®-AH is relevant and meaningful for at least one DHB and can be used to better understand deficiencies in hospital medication systems and help refine improvement initiatives. Further research on the correlation of scores obtained from the use of MSSA®-AH with the incidence of adverse medication-related incidents would help determine its predictive value and its suitability as a proxy measure. Intra- and inter-rater reliability testing were not undertaken, but would have helped determine if the ratings were consistent among different groups.

The experiences and lessons learnt from the use of MSSA®-AH in the hospitals of a New Zealand DHB have implications for policy. The Health Quality and Safety Commission (HQSC), a national organisation charged with identifying key measures to inform and monitor improvements in safety, has struggled to find a suitable indicator relating to medication safety.⁴⁴ Only as recently as September 2014, has an indicator for quality and safety related to medicines use been introduced.⁴⁵ This ‘measure’ asked DHBs whether eMedicines Reconciliation had been implemented or not. While medicines reconciliation is an important process in contributing to safe medicines use, it is only one part of a complex system.⁴⁶ The information that can be obtained from the MSSA®-AH provides a more rounded view, which includes medicines reconciliation but importantly, extends to other key elements of medication safety, such as drug labelling and packaging, and patient education. Coupled with the standardised and systematic approach used for assessment in MSSA®-AH, it may be useful tool which fulfils HQSC requirements.

Conclusion

Using the MSSA®-AH tool has helped WDHB to examine its medication safety system in a rigorous way. MSSA®-AH's unique generation of an overall hospital score helped simplify understanding for non-technical stakeholders. Resources required were nominal, and additional benefits, such as stakeholder engagement, were observed. The intended aim of undertaking the MSSA®-AH was to

provide aspirational goals in order to facilitate learning, prioritise and guide improvement.^{11-13,16} Future repeated assessments would help WDHB track progress. Used for identifying and informing improvement priorities the MSSA®-AH offers a pragmatic and relevant approach. The use of MSSA®-AH and information obtained was of utility to WDHB and may be applicable for other New Zealand hospitals to assess its medication systems for patient safety.

Appendix 1: Medication System Review (MSR) team members and their roles

Recommended personnel or equivalent by MSSA-AH®	Staff member	Role in hospital
Team Leader and patient safety officer	Dr Jerome Ng	Lead for Clinical Quality improvement and Informatics
Senior Hospital administrator	Dr Penny Andrew	Clinical Leader Quality
	Dr Jocelyn Peach	Director of Nursing and Midwifery
At least two staff doctors from different specialty areas	Dr Jonathon Christiansen	Consultant Cardiology
	Dr Ian Wallace	Consultant Gastroenterology/General Medicine
	Dr Robert Wakuluk	Renal registrar
At least two staff nurses from different specialist areas	Ms Janine Quiding	Child Health Nurse Educator
	Ms Sylvie Dombroski	Nurse Educator – New Graduates
	Mr Brian Leaman	Charge Nurse Manager Taharoto Mental Health Unit
Director of Pharmacy	Ms Marilyn Crawley	Chief Pharmacist
Information Technology (IT) representative	Mr David Ryan	eMedicines Project Lead, Pharmacy Operations Manager
At least two staff pharmacist	Ms Nicola Williams	Team leader
	Ms Jenny Young	Team leader
	Mr Wynn Pevreal	Medication safety pharmacist
Additional staff co-opted for the review of particular items	Mr Bill MacDougall	Clinical Engineering
	Ms Julie Bromley	Charge Anaesthetic Technician
	Dr Remy Lim	Consultant radiologist
	Dr David Cranefield	Clinical Director – Radiology
	Ms Jenny Crawford	Paediatric pharmacist
	Ms Kim Rogers	Dispensary manager

Appendix 2: The ten key elements of safe medication use contained in the MSSA®-AH tool (reproduced from ¹²)

Components of a safe medication system	Description and rationale for why the element is fundamental to safe medication use
Element 1: Patient information	Obtaining the patient's pertinent demographic (age, weight) and clinical (allergies, lab results) information that will assist practitioners in selecting the appropriate medications, doses and routes of administration. Having essential patient information at the time of medication prescribing, dispensing and administration will result in a significant decrease in preventable adverse drug events (ADEs).
Element 2: Drug information	Providing accurate and usable drug information to all healthcare practitioners involved in the medication-use process reduces the amount of preventable ADEs. Not only should drug information be readily accessible to the staff through a multitude of sources (drug references, formulary, protocols, dosing scales...), it is imperative that the drug information is up to date as well as accurate.
Element 3: Communication of drug information	Miscommunication between physicians, pharmacists and nurses is a common cause of medication errors. To minimise the amount of medication errors caused by miscommunication it is always important to verify drug information and eliminate communication barriers.
Element 4: Drug labelling, packaging and nomenclature	Drug names that look-alike or sound-alike, as well as products that have confusing drug labelling and non-distinct drug packaging significantly contribute to medication errors. The incidence of medication errors is reduced with the use of proper labelling and the use of unit dose systems within hospitals.
Element 5: Drug storage, stock, standardisation, and distribution	Standardising drug administration times, drug concentrations, and limiting the dose concentration of drugs available in patient care areas will reduce the risk of medication errors or minimize their consequences should an error occur.
Element 6: Drug device acquisition, use and monitoring	Appropriate safety assessment of drug delivery devices should be made both prior to their purchase and during their use. Also, a system of independent double-checks should be used within the institution to prevent device related errors such as, selecting the wrong drug or drug concentration, setting the rate improperly, or mixing the infusion line up with another.
Element 7: Environmental factors	Having a well-designed system offers the best chance of preventing errors; however, sometimes the environment in which we work contributes to medication errors. Environmental factors that often contribute to medications errors include poor lighting, noise, interruptions and a significant workload.
Element 8: Staff competency and education	Staff education should focus on priority topics, such as: new medications being used in the hospital, high- alert medications, medication errors that have occurred both internally and externally, protocols, policies and procedures related to medication use. Staff education can be an important error preventions strategy when combined with the other key elements for medication safety.
Element 9: Patient education	Patients must receive ongoing education from physicians, pharmacists and the nursing staff about the brand and generic names of medications they are receiving, their indications, usual and actual doses, expected and possible adverse effects, drug or food interactions, and how to protect themselves from errors. Patients can play a vital role in preventing medication errors when they have been encouraged to ask questions and seek answers about their medications before drugs are dispensed at a pharmacy or administered in a hospital.
Element 10: Quality processes and risk management	The way to prevent errors is to redesign the systems and processes that lead to errors rather than focus on correcting the individuals who make errors. Effective strategies for reducing errors include making it difficult for staff to make an error and promoting the detection and correction of errors before they reach a patient and cause harm.

Appendix 3: The 20 core characteristics of a safe medication system contained in the MSSA®-AH tool (reproduced from ¹²)

Core characteristic:	
1	Essential patient information is obtained, readily available in useful form, and considered when prescribing, dispensing, and administering medications.
2	Essential drug information is readily available in useful form and considered when ordering, dispensing, and administering medications.
3	A controlled drug formulary system is established to limit choice to essential drugs, minimise the number of drugs with which practitioners must be familiar, and provide adequate time for designing safe processes for the use of new drugs added to the formulary.
4	Methods of communicating drug orders and other drug information are standardised and automated to minimise the risk for error.
5	Strategies are undertaken to minimise the possibility of errors with drug products that have similar or confusing manufacturer labelling/packaging and/or drug names that look and/or sound alike.
6	Readable labels that clearly identify drugs are on all drug containers, and drugs remain labelled up to the point of actual drug administration.
7	Intravenous (IV) solutions, drug concentrations, doses, and administration times are standardised whenever possible.
8	Medications are provided to patient care units in a safe and secure manner and available for administration within a time frame that meets essential patient needs.
9	Unit-based floor stock is restricted.
10	Hazardous chemicals are safely sequestered from patients and not accessible in drug preparation areas.
11	The potential for human error is mitigated through careful procurement, maintenance, use, and standardisation of devices used to prepare and deliver medications.
12	Medications are prescribed, transcribed, prepared, dispensed, and administered in a physical environment that offers adequate space and lighting, and allows practitioners to remain focused on medication use without distractions.
13	The complement of qualified, well-rested practitioners matches the clinical workload without compromising patient safety.
14	Practitioners receive sufficient orientation to medication use and undergo baseline and annual competency evaluations of knowledge and skills related to safe medication practices.
15	Practitioners involved in medication use are provided with ongoing education about medication error prevention and the safe use of drugs that have the greatest potential to cause harm if misused.
16	Patients are included as active partners in their care through education about their medications and ways to avert errors.
17	A non-punitive, system-based approach to error reduction is in place and supported by management, senior administration, and the Board of Trustees/Directors.
18	Practitioners are stimulated to detect and report errors, and interdisciplinary teams regularly analyse errors that have occurred within the organisation and in other organisations for the purpose of redesigning systems to best support safe practitioner performance.
19	Simple redundancies that support a system of independent double checks or an automated verification process are used for vulnerable parts of the medication system to detect and correct serious errors before they reach patients.
20	Proven infection control practices are followed when storing, preparing, and administering medications.

Competing interests: Nil**Acknowledgements:**

New South Wales, Clinical Excellence Commission (CEC). Use of images from the Australian MSSA®-AH database in the manuscript has been approved by CEC. Thanks to the Institute of Safe Medicines Practice (Michael Cohen and Allen Vaida) for the use of the electronic database and MSSA® respectively. Waitemata DHB Medication Systems Review Group (WDHB-MSR group): Jerome Ng, Marilyn Crawley, Wynn Pevreal, Penny Andrew, Jocelyn Peach, David Ryan, Robert Wakuluk, Sylvie Dombroski, Jenny Young, Jonathon Christiansen, Nicola Williams, Brian Leaman, Janine Quiding, and Ian Wallace. Acknowledgements to the following people for their support, comments and involvement: Medication safety group, Andrew Brant, Jenny Crawford, Kim Rogers, Remy Lim, David Cranefield, Bill MacDougall, Julie Bromley, Shane Scahill and Jeff Harrison.

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www.nzma.org.nz/journal/read-the-journal/all-issues/2010-2019/2016/vol-129-no-1430-19-february-2016/6816

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