International Journal of Clinical Pharmacy (2019) 41:445–451
https://doi.org/10.1007/s11096-019-00801-x

RESEARCH ARTICLE

Impact of a pharmacy technician on clinical pharmacy services in an Australian hospital

Jessica T. V. Nguyen[1] · Kate E. D. Ziser[2] · Jonathan Penm[3] · Carl R. Schneider[4]

Received: 17 July 2018 / Accepted: 19 February 2019 / Published online: 12 March 2019
© Springer Nature Switzerland AG 2019

Abstract

Background There is increasing recognition for the role of pharmacy technicians in obtaining medication histories and performing administrative tasks which may represent an opportunity cost when completed by pharmacists. Technician-enhanced teams can therefore improve hospital clinical pharmacy services. In Australian hospitals, medication reconciliation and reviews can be documented in Medication Management Plans (MMPs) upon admission. Thus, MMPs can be used as feasible measures of the efficiency of pharmacy teams. *Objective* To quantify the impact of a technician-enhanced clinical pharmacy model on medication reconciliation and timeliness of pharmacist tasks. *Setting* 480-bed tertiary teaching hospital in New South Wales. *Method* The effect of a technician working alongside the geriatric pharmacist in a single hospital was evaluated. Outcomes were measured throughout two 4-week periods pre- and post-implementation for patients under the supervision of a geriatrician who were discharged during usual business hours. Data were collected by the supervising pharmacist. *Main outcome measure* Primary outcomes were the number of MMPs completed daily on average and during admission, as well as the timeliness of updating discharge summaries, medication histories and MMPs. *Results* The mean number of daily MMPs significantly increased from 2.25 to 4.90 with the technician ($p < 0.001$, 95% CI 1.66 to 3.64). The median time to update discharge summary significantly decreased from 6:48 to 2:33 h ($p = 0.01$). *Conclusion* This study suggested that technician-enhanced teams could improve the efficiency of clinical pharmacy services in an Australian hospital.

Keywords Australia · Clinical pharmacy · Geriatric · Hospital · Hospital pharmacy · Medication reconciliation · Pharmacy technician

Impact on Practice

- Technicians can improve team efficiency in Australian hospital pharmacies, in terms of practical measures, including the average number of Medication Management Plans completed daily and time taken to complete key tasks.
- Future research should involve development of a formal training package which include the five key competencies identified in the study described here.

Introduction

Internationally, suboptimal medication management and adverse drug events can contribute to 28% of potentially preventable hospital readmissions within 30 days [1]. In addition to adverse patient outcomes, medication-related

✉ Jessica T. V. Nguyen
thng0117@uni.sydney.edu.au

[1] The University of Sydney School of Pharmacy, Faculty of Medicine and Health, Pharmacy and Bank Building A15, The University of Sydney, Camperdown, NSW 2006, Australia

[2] Department of Pharmacy, Royal North Shore Hospital, Reserve Rd, St Leonards, NSW 2065, Australia

[3] The University of Sydney School of Pharmacy, Faculty of Medicine and Health S303, Pharmacy and Bank Building A15, The University of Sydney, Camperdown, NSW 2006, Australia

[4] The University of Sydney School of Pharmacy, Faculty of Medicine and Health N508, Pharmacy and Bank Building A15, The University of Sydney, Camperdown, NSW 2006, Australia

issues create a financial burden on the national health care system [2]. Medication-related issues can occur through transcription errors resulting in clinically inappropriate discrepancies between medications prescribed or administered between one care setting and the next [2]. Medication reconciliation, traditionally a pharmacist's role, is a key step to minimising medication discrepancies during transitions of care and subsequent drug-related problems (DRPs) [3].

In Australian hospitals, medication reconciliation and reviews can be documented in Medication Management Plans (MMPs) upon admission, as per guidelines from the Society of Hospital Pharmacists of Australia (SHPA) [4]. These involve obtaining a best possible medication history (BPMH) using several sources, reconciling it against the inpatient orders and, in some institutions, clinically reviewing the patient, with issues and recommendations noted for the treating team [4–6]. Ideally the document is updated until discharge, and communicated to the next health care professional [7]. Clinical pharmacists dynamically review inpatients from admission up to and including discharge. At discharge, the pharmacist reconciles the inpatient medication charts with the discharge prescription. If required, a medication list will be provided and an updated dose administration aid ordered from the patient's community pharmacy. Such methods of medication management are demonstrated to improve appropriateness of medications and hence patient outcomes, preventing up to 84% of potentially harmful adverse drug events [6, 8–10]. Consequently, the European Statements of Hospital Pharmacy, published by the European Association of Hospital Pharmacists (EAHP), endorse pharmacists reviewing appropriateness of all medications and conveying medication-related information across transitions of care, especially admission to hospital [3].

Although some guidelines recommend medication history-taking and reconciliation be performed within 24 h of admission [9, 11–13], recent studies have shown that a timeframe of 48 h still reduces unintentional discrepancies, especially with a team-based service [14–16]. Internationally, medication reconciliation as well as individual elements such as the BPMH are effectively performed by non-pharmacist members of the pharmacy team such as pharmacy technicians and students [6]. Having pharmacists perform tasks which may be completed by a pharmacy technician represents an opportunity cost as pharmacists' clinical expertise may be applied elsewhere. This can involve latter stages of medication reconciliation, reviewing to identify DRPs and initiating clinical interventions to manage these DRPs prior to discharge, to help minimise patient harm [5, 6, 17, 18]. Compared to physicians and nurses, pharmacy technicians (under pharmacist supervision) obtain significantly more accurate histories in a shorter period [6, 10] and can perform medication reconciliation [18].

There is a growing body of evidence which describes technicians' roles potentially expanding to include aspects of medication reconciliation. These are primarily from the United States and United Kingdom and appear to operate on ward-based models [19–23]. The EAHP Statements recognise that "clinical pharmacy services should continuously evolve to optimise patients' outcomes" but do not mention pharmacy technicians [3]. Therefore, to our knowledge, this is the first study to explore the feasibility of a team-based pharmacy technician in a context wherein a more advanced clinical support role is not yet well-established.

Aim

This study aimed to quantify the impact of a technician-enhanced clinical pharmacy service model on the proportion of BPMHs taken and MMPs generated in a timely manner. The primary endpoints were the mean number of MMPs completed daily and timeliness of completing MMPs and discharge summaries. Secondary outcomes measured were the type of DRP and whether being on the geriatric ward correlated to receiving MMPs within a shorter timeframe. Understanding the type of DRPs provides insight into the type of interventions required. Furthermore, it has been demonstrated that there is no difference between pharmacists and pharmacy technicians in obtaining accurate BPMHs [24, 25].

Ethics approval

This study was classified as a quality improvement project by the Patient Safety and Quality Unit of the hospital and was not required to obtain formal ethics approval. All procedures performed were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

Method

This prospective pre-post single-arm experimental study involved a single pharmacy technician working under one speciality (geriatrics) which services 30–60 patients within a 480-bed tertiary teaching hospital in New South Wales.

Technician training and implementation of the team-based model

With electronic access to all required programs, the pharmacy technician was trained in five key competencies:

1. Updating the medication list in the electronic discharge summary
2. Creating a medication list for patient counselling
3. Taking a BPMH from a nursing home patient using the nursing home and pharmacy records (no patient contact)
4. Taking a BPMH from a patient and/or carer who manages their own medication (patient/carer contact)
5. Counselling a patient and/or carer on discharge medications (with or without a medication list)

At the time of the trial, the technician had 5.5 and 1 years' experience in community and hospital pharmacy, respectively. She had also completed three certificates in community pharmacy through the Vocational and Educational Training sector and is currently completing an additional certificate in Hospital/Health Services Pharmacy Support. The latter is a 1-year course delivered online and has no entry requirements, although students must be employed in a hospital pharmacy [26]. It primarily focuses on technical skills including compounding and dispensing. Prior to the trial, the technician was trained for approximately 3 h weekly, totalling 26.5 h prior to trial commencement, with each competency signed off after completion for 20 patients under geriatric pharmacist supervision. The technician completed competencies (1) and (2) but due to staffing restraints could only complete competencies (3) and (4) during the trial period; competency (5), which was of lower priority, was started towards the end of the trial. During the trial period, the technician worked from Monday to Friday 8:00 am to 5:00 pm to align with the pharmacist's hours.

The pharmacist was responsible for supervising the technician and verified the technician's BPMH against one hard-copy source, such as the patient's own medications or fax from a community pharmacy showing medications packed in dose administration aids. Additionally, the pharmacist reconciled medications for discharge, performed clinical reviews and interventions, consulted with the medical team and obtained BPMHs if the technician required assistance.

Data collection

The inclusion criteria for the audit were any patients under the care of a geriatrician and discharged during the service hours of Monday to Friday from 8:00 am to 5:00 pm during the 4 weeks of data collection from October to November 2017 for the pre-implementation period, and January to February 2018 for the post-implementation of the pharmacy team-based service. Patients were de-identified and assigned codes designated by the researchers.

The study hospital's electronic medical record system (PowerChart, Cerner Millenium) was used to collect data on time of admission, time between writing of the discharge summary by the prescriber and its subsequent updating by the pharmacy team, time and number of MMPs and where relevant, BPMHs (to be followed up by MMPs). These were used as measures of the pharmacy team's efficiency. The identity of the pharmacist or technician who updated each discharge summary, BPMH and MMP was also recorded. For the selected patients who received MMPs, each DRP was recorded and categorised by one author according to a previously validated Australian DRP taxonomy [27]. The patient's ward was also recorded to identify any association between the timeliness of MMPs and whether a patient was located on the geriatric ward.

Data analysis

IBM SPSS Statistics (version 24) was used to analyse the data. An independent samples t test was performed on the daily number of MMPs; Pearson Chi squared tests on percentages of patients receiving MMPs relative to technician employment or ward location; and Mann–Whitney U-tests on non-normally distributed patient ages and times taken to complete activities. A value of $p < 0.05$ was interpreted as statistically significant for all comparative tests. Where available in SPSS, Yates' Continuity Correction was applied for Chi squared analysis.

Results

A total of 81 and 147 patients were eligible for analysis in the pre- and post-implementation periods, with median ages (IQR) of 89 (86.5–91.5) versus 89 (86.0–92.0) years and gender distributions of 68 versus 62% female, respectively.

In terms of daily workload, the mean (± SD) number of MMPs completed without the technician was 2.25 (± 1.55), significantly increasing to 4.90 (± 1.55) with the technician joining the geriatric team ($p < 0.001$, 95% CI 1.66 to 3.64) (Table 1).

Table 1 The total and daily mean number of Medication Management Plans completed, pre- and post-implementation of the team-based technician

	No Technician (n = 81)	Technician (n = 147)	*p* value
Number of MMPs completed daily (mean ± SD)	2.25 ± 1.55	4.90 ± 1.55	< 0.001*
Number (%) of patients who received MMPs during admission	49 (60.5%)	97 (66.0%)	0.50

*Denotes statistical significance, independent samples t-test ($p < 0.05$)

The median time to complete a BPMH with a technician on the team was 22:54 h (Table 2). The median time to complete an MMP without and with a pharmacy technician were 48:42 h; and 25:06 h, respectively ($p=0.26$). Conversely, median time to update discharge summary significantly decreased from 6:48 to 2:33 h ($p=0.01$). Of the increased work completed during the implementation of the technician-enhanced team model, the percentages of BPMHs and discharge summaries updated by the technician were 55.7% (n = 54/97) and 72.6% (n = 98/135) respectively. Of the 147 post-implementation patients, 34.7% had BPMHs obtained by the pharmacy team within 24 h of admission.

All issues identified on the MMPs are presented in Table 3. Of all the MMPs evaluated during the pre- and post-implementation periods (n = 409), the most frequent DRP at 26.9% was the drug order being incorrect, incomplete or discrepant, followed by missing therapy which comprised 14.2% of the identified issues.

The proportion of patients that received an MMP within 24 h was significantly greater on the geriatric ward compared to other wards (34.5% (n = 30) vs. 22.6% (n = 7), $p=0.01$), although there was no difference by 48 h (49.4% (n = 43) vs. 45.2% (n = 14), $p=0.23$). There was also a statistically significant difference in the proportion of patients with MMPs during admission (74.7% (n = 65) on the geriatric ward vs. 48.4% (n = 15) on other wards, $p=0.02$).

Discussion

To our knowledge, this is the first study which has evaluated service-delivery outcomes of a newly-implemented technician-enhanced team-based clinical pharmacy service model. The model was associated with an increase in the mean number of MMPs completed daily, reduced time to complete MMPs and discharge summaries and helped detect DRPs, mostly those relating to drug orders.

The mean number of daily MMPs more than doubled during the study period; this may have been subject to opportunity as there were almost twice as many discharges in the post-implementation period (81 vs. 147). The antecedent increase in admissions presented a greater opportunity to complete MMPs in a timely manner. At the study hospital, discharge processing took priority and MMPs were

Table 2 Median (IQR) times to update medication histories, Medication Management Plans and discharge summaries, with and without a team technician

Time to update	No technician		Technician		
	Median (IQR) (hh:mm)	n	Median (IQR) (hh:mm)	n	*p* value
Best possible medication history	[a]		22:54 (16:00, 65:55)	97	–
Medication management plan	48:42 (14:08, 139:10)	49	25:06 (17:25, 68:30)	97	0.26
Discharge summary	06:48 (01:46, 28:37)	65	02:33 (01:21, 19:28)	135	0.01*

*Denotes statistical significance, Mann–Whitney U Test ($p<0.05$)

[a]Time to medication histories during the pre-implementation period was not recorded as they were updated by pharmacists directly before an MMP

Table 3 All drug-related issues from Medication Management Plans

Classification (n = 409)	Frequency	Percent
Drug order incorrect, incomplete, illegible, discrepant	110	26.9
Indication not treated/missing therapy	58	14.2
No indication	40	9.8
No or too infrequent monitoring	32	7.8
Inappropriate: contraindicated, ineffective, not safest	27	6.6
Dose too high	22	5.4
Change in disease state requiring dose adjustment	22	5.4
Prescribed drug not available	16	3.9
ADR occurred	11	2.7
Other[a]	71	17.4
Total	409	100.0

The absolute occurrence and percentage of issues were reported

[a]Included: suboptimal regimen frequency; inappropriate/suboptimal drug form; drug use process; synergistic/preventative drug missing; drug not consumed at all; unable to store or use/doesn't use drug/form as directed; inadequate information or not understood/followed; treatment duration too short or long; dosage instructions unclear, incomplete, not understood by patient/carer; dose selection; drug under- or over-used; dose too low; inappropriate combination of drugs/food/alcohol

completed in the time between discharges. Hence there was almost twice as much baseline work for the pharmacy team as opposed to when the pharmacist was working alone. The increased efficiency may be attributed to the technician having specific roles without having to attend to additional responsibilities of pharmacists (e.g. discharge medication reviews) [6, 28]. The technician obtained and updated BPMHs for most patients (54/97) in our study. As this was a newly implemented technician-enhanced service model, ward staff lack of familiarity of the technician role may have reduced the team's efficiency. Conversely, a study by Elliott et al. [23] included a 0.4 full-time equivalent ward-based technician at baseline and observed an even higher rate of technician assistance on admission (167/193). This highlights the potential differences between upskilling a previously established role and implementing a new technician-enhanced clinical service model, within a national setting where more advanced technician roles are not ubiquitous or well-established.

The median time to complete an MMP, while falling from 48:42 to 25:06 h, did not reach significance. The equivalent service-delivery endpoint reported by Elliott et al. [23] was the median time until the first clinical pharmacist review, which significantly improved from 5.5 to 3.0 days. The non-significance observed in the present study may be attributed to the difference in baseline times to complete MMPs between the two studies, suggesting a more limited scope for improvement in the present study. Alternatively, the sample size in the present study may have been underpowered to detect significant differences compared to Elliott et al. There is opportunity to revisit this study with a larger sample size and conduct data collection over a longer period.

The median time to update discharge summaries significantly improved with the technician. The improved checking, discrepancy-resolution and subsequent updating of discharge summaries may be explained by the patient already having a baseline BPMH and this not needing to be obtained for the first time by a pharmacist on discharge. Many pharmacists place a high priority on discharge processes due to the gap in communication and care between prescribers and patients. This necessitates explanation of discharge medications to patients or organisation of new dose administration aids.

The most frequent DRP at 26.9% was the drug order being incorrect, incomplete or discrepant. In accordance with previous studies, a clear majority of the DRPs were transcription discrepancies occurring due to the transition of care into the hospital [7, 9]. This is an emphatic reminder of the need for accurate BPMHs which can be obtained by a trained pharmacy technician. Future studies could supplement this research by conducting harm severity ratings for each DRP identified on the MMPs and potential economic benefits of resolving these DRPs. Alternatively, changes in Drug Burden Index (DBI) scores [29] could be investigated for issues involving anticholinergic and sedative medications to evaluate clinically significant harm reduction enabled by having a technician on the team. DBI would be a more accurate indicator of patient safety compared to the surrogate measure of MMPs used in this study. Moreover, a significantly higher proportion of patients on the geriatric ward received MMPs within 24 h and during admission, supporting the need for future studies on improving inter-ward care and communication between different medical teams.

This study possessed several strengths. Firstly, recording time to complete BPMHs rather than the duration of history-taking alone reflected the workflow of the team in a patient-centred context, rather than focusing on one of the many tasks of the technician such as compiling a BPMH, which previous studies have done [6]. Secondly, the geriatric admissions in this study, although medically complex, reflected a large proportion of the ageing population with co-morbidities and polypharmacy and hence high risk of DRPs at transitions of care [9, 17]. On the other hand, this study was limited by its partly retrospective baseline data collection, which limited follow-up of several data points, such as the wards of some patients or cause of a DRP which hindered classification. It was a single centre, non-blinded audit in one ward of a tertiary hospital, and therefore generalisability was limited. As the post-implementation study period commenced immediately after 26.5 h of training, the technician's proficiency could still have been improving and the ward staff still adjusting to the new technician during the trial period, potentially introducing bias and limiting the scope for inter-study comparisons [23]. An informal regular feedback tool or formal evaluation tool could have been developed for quality assurance but was beyond the scope of this feasibility study. Quality assurance should be further explored as there are conflicting data on the satisfaction of ward staff with the pharmacist-technician team model [23, 30].

Conclusion

A technician-enhanced pharmacy team improved the efficiency of clinical pharmacy services in an Australian hospital. The technician significantly improved the mean number of MMPs completed daily, the time taken to update discharge summaries and helped detect DRPs, mostly those relating to drug orders and missing therapy. The discrepancy in time to complete MMPs based on ward location implied a need for further studies on improving inter-ward care and communication. Thus, as hospital pharmacy services advance in scope and demand internationally, further studies are required to confirm the external validity of integrating technician roles into the clinical pharmacy team.

Acknowledgements We would like to thank Ms. Nicole Meehan, Ms. Samantha Brown, Ms. Cecilia Chan, Ms. Jennifer Ly and staff at RNSH for all their help on this project. JN received funding through a summer scholarship from the University of Sydney School of Pharmacy.

Funding Funding was provided by the School of Pharmacy, University of Sydney (Grant No. SC1789).

Conflicts of interest JN received funding through a summer scholarship from the University of Sydney School of Pharmacy. KZ, JP, CS declare that they have no conflict of interest.

References

1. Feigenbaum P, Neuwirth E, Trowbridge L, Teplitsky S, Barnes CA, Fireman E, et al. Factors contributing to all-cause 30-day readmissions a structured case series across 18 hospitals. Med Care. 2012;50(7):599–605.
2. Institute of Medicine. Preventing medication errors. Washington: The National Academies Press; 2007.
3. European Journal of Hospital Pharmacy. The European statements of hospital pharmacy. Eur J Hosp Pharm. 2014;21(5):256–8. https://doi.org/10.1136/ejhpharm-2014-000526.
4. Society of Hospital Pharmacists of Australia. Medicines in focus background material—medication reconciliation. In: Fact sheets & position statements. SHPA, Collingwood, VIC. 2012. https://www.shpa.org.au/sites/default/files/uploaded-content/website-content/Fact-sheets-position-statements/final_medrecbackground28nov2012.pdf. Accessed 13 June 2018.
5. Australian Commission on Safety and Quality in Health Care. National Safety and Quality Health Service Standards. ACSQHC, Sydney, NSW. 2017. https://www.safetyandquality.gov.au/wp-content/uploads/2017/12/National-Safety-and-Quality-Health-Service-Standards-second-edition.pdf. Accessed 13 May 2018.
6. Champion HM, Loosen JA, Kennelty KA. Pharmacy students and pharmacy technicians in medication reconciliation: a review of the current literature. J Pharm Pract. 2017. https://doi.org/10.1177/0897190017738916.
7. Hammad EA, Bale A, Wright DJ, Bhattacharya D. Pharmacy led medicine reconciliation at hospital: a systematic review of effects and costs. Res Soc Adm Pharm. 2017;13(2):300–12.
8. Viswanathan M, Kahwati LC, Golin CE, Blalock SJ, Coker-Schwimmer E, Posey R, et al. Medication therapy management interventions in outpatient settings: a systematic review and meta-analysis. JAMA Internal Med. 2015;175(1):76–87.
9. Tong EY, Roman CP, Smit D, Newnham H, Galbraith K, Dooley MJ. Partnered medication review and charting between the pharmacist and medical officer in the Emergency Short Stay and General Medicine Unit. Australas Emerg Nurs J. 2015;18(3):149–55.
10. Kraus SK, Sen S, Murphy M, Pontiggia L. Impact of a pharmacy technician-centered medication reconciliation program on medication discrepancies and implementation of recommendations. Pharm Pract. 2017. https://doi.org/10.18549/PharmPract.2017.02.901.
11. NPS Medicinewise. The importance of medication reconciliation for patients and practitioners. NPS Medicinewise, Surry Hills, NSW. 2012. https://www.nps.org.au/australian-prescriber/articles/the-importance-of-medication-reconciliation-for-patients-and-practitioners-r5. Accessed 28 March 2018.
12. Cadman B, Wright D, Bale A, Barton G, Desborough J, Hammad EA, et al. Pharmacist provided medicines reconciliation within 24 hours of admission and on discharge: a randomised controlled pilot study. BMJ Open. 2017. https://doi.org/10.1136/bmjopen-2016-013647.
13. Australian Commission on Safety and Quality in Health Care. National Safety and Quality Health Service Standards guide for hospitals. ACSQHC, Sydney, NSW. 2017. https://www.safetyandquality.gov.au/wp-content/uploads/2017/12/National-Safety-and-Quality-Health-Service-Standards-Guide-for-Hospitals.pdf. Accessed 10 April 2018.
14. Beckett RD, Crank CW, Wehmeyer A. Effectiveness and feasibility of pharmacist-led admission medication reconciliation for geriatric patients. J Pharm Pract. 2012;25(2):136–41.
15. Magalhaes GF, Santos G, Rosa MB, Noblat L. Medication reconciliation in patients hospitalized in a cardiology unit. PLoS One. 2014. https://doi.org/10.1371/journal.pone.0115491.
16. Byrne SM, Grimes TC, Jago-Byrne MC, Galvin M. Impact of team-versus ward-aligned clinical pharmacy on unintentional medication discrepancies at admission. Int J Clin Pharm. 2017;39(1):148–55.
17. Tong EY, Roman CP, Mitra B, Yip GS, Gibbs H, Newnham HH, et al. reducing medication errors in hospital discharge summaries: a randomised controlled trial. Med J Aust. 2017;206(1):36–9.
18. Penm J, Vaillancourt R, Pouliot A. Defining and identifying concepts of medication reconciliation: an international pharmacy perspective. Res Soc Adm Pharm. 2018. https://doi.org/10.1016/j.sapharm.2018.07.020.
19. Conroy C, Cattell R, Nicholls M. Contribution of a ward-based technician service to delivering effective patient health care and reducing dispensary workload. Int J Pharm Pract. 2002;10(3):171–5.
20. Sen S, Siemianowski L, Murphy M, McAllister SC. Implementation of a pharmacy technician-centered medication reconciliation program at an urban teaching medical center. Am J Health Syst Pharm. 2014;71(1):51–6.
21. Alkhateeb FM, Shields KM, Broedel-Zaugg K, Bryan A, Snell J. Credentialing of pharmacy technicians in the USA. Int J Pharm Pract. 2011;19(4):219–27.
22. Society of Hospital Pharmacists of Australia. Exploring the Role of Hospital Pharmacy Technicians and Assistants to Enhance the Delivery of Patient Centred Care—A White Paper on the Findings and Outcomes of the 'Pharmacy Technician and Assistant Role Redesign within Australian Hospitals (Redesign) Project'. 2016. https://www.shpa.org.au/sites/default/files/uploaded-content/website-content/final_tech_redesign_white_paper_november_revision.pdf. Accessed 20 Nov 2018.
23. Elliott RA, Perera D, Mouchaileh N, Antoni R, Woodward M, Tim T, et al. Impact of an expanded ward pharmacy technician role on service-delivery and workforce outcomes in a subacute aged care service. J Pharm Pract Res. 2014;44(3):95–104.
24. Pevnick JM, Nguyen C, Jackevicius CA, Palmer KA, Shane R, Cook-Wiens G, et al. Improving admission medication reconciliation with pharmacists or pharmacy technicians in the emergency department: a randomised controlled trial. BMJ Qual Saf. 2018;27(7):512–20.
25. Chan C, Woo R, Seto W, Pong S, Gilhooly T, Russell J. Medication reconciliation in pediatric cardiology performed by a pharmacy technician: a prospective cohort comparison study. Can J Hosp Pharm. 2015;68(1):8–15.
26. TAFE NSW. Certificate IV in Hospital/Health Services Pharmacy Support—HLT47115-01V02-18WCN-051—Western Connect. TAFE NSW, NSW. https://www.tafensw.edu.au/offering/-/o/o/HLT47115-01V02-18WCN-051/Certificate-IV-in-Hospital-Health-Services-Pharmacy-Support. Accessed 20 Nov 2018.
27. Basger BJ, Moles RJ, Chen TF. Development of an aggregated system for classifying causes of drug-related problems. Ann Pharmacother. 2015;49(4):405–18.

28. Mabasa VH, Malyuk DL, Tung A, Balen RM, Nicolls TR, Rahiman NL. Using clinical pharmacy support technicians to optimize pharmaceutical care in the intensive care unit. Can J Hosp Pharm. 2010;63(1):41–5.
29. Hilmer SN, Mager DE, Simonsick EM, Cao Y, Ling SM, Windham BG, et al. A drug burden index to define the functional burden of medications in older people. Arch Internal Med. 2007;167(8):781–7.
30. Bryant R, Chaar B, Schneider C. Differing clinical pharmacy service models: quantitative and qualitative analysis of nurse perceptions of support from pharmacists. Int J Nurs Stud. 2018. https://doi.org/10.1016/j.ijnurstu.2018.04.003.

Publisher's Note Springer Nature remains neutral with regard to jurisdictional claims in published maps and institutional affiliations.