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Abstract

Background: Qualitative studies have provided important insights into how hospital pharmacists' work changes when electronic medication management (EMM) systems are introduced. Quantitative studies of work practice change are rare. Despite the use of EMM systems internationally, there are no cross-country comparative studies of their impact on health professionals' work. We aimed to quantify and compare the type and magnitude of changes in hospital pharmacists' work pre- and post-EMM implementation in two countries. Methods: Parallel, direct observational, time and motion studies of pharmacists in Australia and England pre- and post-EMM implementation. 20 pharmacists were observed: 9 in an Australian 440-bed hospital (155 hours); and 11 pharmacists in a 500-bed English hospital (258 hours). The Work Observation Method By Activity Timing (WOMBAT) software was used to collect observational data. Proportions of observed time in 11 tasks by study period (pre- versus post-EMM) and site, time spent with others or alone, and using different tools (e.g computers, paper) were calculated. Magnitude of changes between pre- and post-EMM by task and country were determined using z-tests for proportions adjusting for multiple testing. Results: At baseline, Australian and English pharmacists spent the greatest proportion of time in medication review. Post-EMM, time in medication review (Australia 21.6% to 27.5%; England 27.1% to 33.8%) and history-taking (Australia 7.6% to 13.3%; England 19.5% to 28.9%) significantly increased. Despite country differences in these tasks at baseline, the magnitude of changes did not significantly differ. English pharmacists increased time engaged in medication discussions with patients post-EMM (from 5.9% to 10.8%; p=0.01). The Australian rate did not change (18.0% to 27.2%; p=0.09), but was higher at baseline. Post-EMM, Australian pharmacists spent 63.4% of time working alone, compared to 92.0% for English pharmacists. Conclusions: EMM systems impacted the same core areas of work and had a similar magnitude of effect on pharmacists' work in both countries. Anticipated reductions in medication review and history taking were not observed.

Keywords	computerised provider order entry system; time and motion; electronic health records; electronic prescribing; observation
Taxonomy	Pharmacy, eHealth, Electronic Health Record

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Highlights

- Australian and English pharmacists' work patterns significantly differed at baseline
- Electronic medication management systems changed the work patterns of pharmacists
- The same magnitude of effect on pharmacists' work in each country was found
- Cross-country studies help understand how systems integrate in different contexts

A cross-country time and motion study to measure the impact of electronic medication management systems on the work of hospital pharmacists in Australia and England

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Methods: Parallel, direct observational, time and motion studies of pharmacists in Australia and England pre- and post-EMM implementation. 20 pharmacists were observed: 9 in an Australian 440-bed hospital (155 hours); and 11 pharmacists in a 500-bed English hospital (258 hours). The Work Observation Method By Activity Timing (WOMBAT) software was used to collect observational data. Proportions of observed time in 11 tasks by study period (pre- versus post-EMM) and site, time spent with others or alone, and using different tools (e.g computers, paper) were calculated. Magnitude of changes between pre- and post-EMM by task and country were determined using z-tests for proportions adjusting for multiple testing.

Results: At baseline, Australian and English pharmacists spent the greatest proportion of time in medication review. Post-EMM, time in medication review (Australia 21.6% to 27.5%; England 27.1% to 33.8%) and history-taking (Australia 7.6% to 13.3%; England 19.5% to 28.9%) significantly increased. Despite country differences in these tasks at baseline, the magnitude of changes did not significantly differ. English pharmacists increased time engaged in medication discussions with patients post-EMM (from 5.9% to 10.8%; p=0.01). The Australian rate did not change (18.0% to 27.2%; p=0.09), but was

higher at baseline. Post-EMM, Australian pharmacists spent 63.4% of time working alone, compared to 92.0% for English pharmacists.

Conclusions: EMM systems impacted the same core areas of work and had a similar magnitude of effect on pharmacists' work in both countries. Anticipated reductions in medication review and history taking were not observed.

Background

Understanding clinical work processes and the ways in which care is delivered to patients is central to designing interventions which improve both work efficiency and clinical outcomes. Health technologies, from electronic health record (EHR) systems[1, 2] to mobile phones[3-5] have impacted on the way hospital clinicians perform their work and the ways in which they engage with each other and their patients. There is a growing body of research which has sought to measure how workflows and patterns change with technology introduction. [6, 7] Much of this research has focused on the work of physicians in hospitals and commenced in response to concerns that the introduction of computers into everyday clinical work reduced efficiency.[8] Early time and motion studies[9] aimed to quantify changes in task time distributions. These initial studies timed how long specific tasks took, for example, how long it took doctors to prescribe on paper medication charts compared to using a computer. Not surprisingly, entering medication orders into a computer took longer on average, than hand writing an order.[9] More sophisticated studies measured an entire suite of clinicians' work and those studies[2] showed that overall, the use of an electronic medication management (EMM; e-prescribing) system did not significantly shift the amount of time that either doctors or nurses spent on key tasks such as time in patient care, professional communication or on medication tasks.

EMM systems have been a major platform by which to secure safety benefits from EHR systems.[10-12] These systems change the entire medication process, from prescribing to dispensing and administration, and as a result impact the work processes of not only doctors and nurses, but also clinical pharmacists. Little research has focused on understanding how these systems influence the work of pharmacists.[13] Promoted benefits of EMM systems for

pharmacists' work include the ability to provide improved data quality (e.g. legible orders) and better access to information for comprehensive patient reviews, both of which have the potential to improve the efficiency of these review processes and thus free pharmacists' time to redistribute to other tasks such as patient counselling. Releasing hospital pharmacists from administrative tasks has been recognised as a priority in the English National Health Service. [14] However, there are also concerns that these EMM systems may result in new tasks which fall to pharmacists (e.g. answering technical queries relating to EMM prescribing).[15]

Despite many large commercial clinical information systems being implemented in multiple countries, cross-country comparisons of the impact of these same systems in different settings are very rare. Thus, the extent to which health technologies have consistent effects in terms of desired work practice changes is unknown. This lack of comparative data has also been hindered by the absence of robust and consistently applied research methods to measure workflow patterns.

The aim of this study was to conduct a cross-country study to investigate the impact of the implementation of EMM systems on hospital pharmacists' work in Australia and England. Both countries have a similar tradition of pharmacist training and practice and have similarities in their public hospital systems.

Materials and Methods

Study Design, Setting and Sample

We designed and conducted parallel direct observational studies of pharmacists' work in an Australian and an English hospital, before and after the introduction of EMM systems. Details of the sample are provided in Table 1. The sampling strategy was prepared to ensure all hours of pharmacists' work on weekdays were sampled proportionately. Participants were observed between the hours of 08:15 and 17:15 on weekdays. The post data collection occurred at least six months post-EMM system implementation to ensure pharmacists were familiar with the system.

	Australian Site (Sydney)	English Site (South England)
	440- bed Tertiary referral public hospital	500-bed public hospital
Baseline pre-EMM data collection	3 wards	4 wards
	18 August 2015 – 1 October 2015	9 February 2015 – 11 March 2015
Post-EMM data collection	3 wards	4 wards
	23 May 2016 – 22 June 2016	5 October 2015 – 29 October 2015
	Minimum 6 months after EMM implementation	Minimum 10 months after EMM implementation
Number of staff observed	9 hospital pharmacists	11 hospital pharmacists
Hours (h) observed	154.5 h (pre: 80.4 h; post: 74.1 h)	258.1 h (pre: 136.7h; post 121.4h)

Table 1 Sample descriptions pre- and post-EMM observations in hospitals in Australia and England

Intervention

Hospital pharmacists at both hospitals had similar roles when on hospital wards. This included the core tasks of establishing patients' medication histories, reviewing medication charts, education and responding to queries of patients and clinical staff, and participating in

inter-professional clinical meetings. All wards used paper medical records and medication charts at baseline. Each hospital introduced a commercial EMM system that interfaced with the hospitals' existing clinical information systems (e.g. which provided ordering of pathology, access to test results). Following implementation, pharmacists had access to computers on wheels, laptops and fixed desktop computers to access the EMM on hospital wards and in the pharmacy departments.

Data Collection

A pharmacy work task classification was developed through an iterative process between the Australian and English teams, comprising 11 broad categories of mutually exclusive work task categories, based upon a previously developed task classification.[13] Each work task category was defined by inclusion and exclusion criteria and pilot tested in the field in both England and Australia (Table 2). The classification was incorporated into the Work Observation Method By Activity Timing (WOMBAT)[16] software on a tablet computer to allow for the consistent recording of observational data. WOMBAT has been used in several previous direct observational studies of clinicians' work in multiple countries.[7, 17-19]

Task Category	**Definition and inclusion and exclusion criteria**
Medication review	Reading/assessing the medication chart, reading/writing notes in the record, or calculating doses. Includes: reviewing and signing the medication chart, reviewing test results, ordering drug monitoring tests, annotating the medication chart, checking antimicrobial approval. Excludes: medication reconciliation (see History taking) and discharge medication review.

Discharge medication review	Reviewing medications on discharge or entering information into an electronic discharge summary. Includes: checking and reconciliation within the discharge summary, transcribing into the discharge summary. Excludes: general transcribing (see Other).
Using drug reference	Seeking medication information from references. Includes: consulting reference material either paper or electronic. Excludes: discussion about medications (see Medication discussion).
History taking	Information gathering/taking a medication history and medication reconciliation. Includes: obtaining medication history and allergy information from a patient, relative, carer, primary health provider, or the patient's personal health record. Excludes: discussions about medications not related to medication history (see Medication discussion).
Medication discussion	Talking about things related to medications including communicating interventions, taking orders, and patient education regarding medications. Includes: phone calls or face-to-face conversations about medications, clinical conversations on ward rounds, questions to doctors/nurses about discharge prescriptions, clarifying medication orders. Excludes: medication history discussions or phone calls/discussion to order medications for stocking on the ward (see Supply medications).

Professional communication	Communicating with other health professionals about work-related matters. Includes: meetings, handover discussions. Excludes: medication-related discussions (see Medication discussion).
Supply medications	Dispensing medications for patients or maintaining ward stock. Includes: data entry, product selection, labelling and checking for medication dispensing, phone calls/conversations to order medications to stock the ward, destruction of expired medications. Excludes: providing medication information to patients when supplying them with their medication (see Medication discussion).
Work organisation tasks	Gathering things/getting ready/organising work. Includes: administrative tasks, printing patient lists, walking around a bay/room to obtain things, looking for something or waiting for someone/something to become available once located. Excludes: periods of waiting on the phone during a conversation or moving locations (see In transit).
In transit	Physically moving locations. Includes: walking from pharmacy to ward or ward to pharmacy, walking from one ward to another, walking on wards from one room to another. Excludes: walking within a bay/room while completing a task or looking for something (see Work organisation tasks).
Social	Social activities, breaks or social conversation that is not medication or work related. Includes: lunch or bathroom breaks, discussions about the weather or weekend activities.

Other	Other tasks not defined above. Includes: general transcribing (re-writing not for the purpose of reconciliation or discharge summary), training others how to use EMM, incident reporting, other patient care.

Table 2 Pharmacy work task classification

The WOMBAT tool also allows for the collection of data about interruptions and tasks undertaken in parallel (multitasking). Observers recorded tasks under four task dimensions: (1) What - the task being performed; (2) Where - the physical location where the task was undertaken; (3) With whom - who the pharmacist was with when performing the task; and (4) How - any tools used to complete the task (e.g. using a computer).

Procedures

Clinical pharmacists at each hospital were invited to participate in the study during an information session, followed by a direct approach by a member of the research team. Following signed consent, pharmacists were assigned an identification number.

All observers were independent from the study hospitals. Observers were trained in the application of the work task classification and use of the WOMBAT tool on a handheld computer. Observers (Australia=2, UK=3) were trained to use the WOMBAT tool using scenarios followed by multiple in-field pilot observation sessions to ensure high levels of reliability. Inter-rater reliability testing was conducted where two observers collected data simultaneously, but independently. Kappa scores for task classification were >0.80 at both sites. Inter-rater reliability was not possible to assess between observers in the different countries, however all observers were trained using the same scenarios and joint

teleconferences with all observers were held to ensure consistency of application of classification definitions and processes.

Observers recorded tasks in real-time while shadowing pharmacists as they conducted their work. Observation sessions were up to two hours in length. Two observers performed up to six hours of observations per day. The Australian study was approved by the hospital's Human Research Ethics Committee and the UK study received institutional research ethics approval from the University of Edinburgh and local governance approval from the hospital Trust.

Statistical analysis

To assess any changes in pharmacists' task time distributions post-EMM, we calculated the proportion of total observed time in each task category by study period (pre- versus post-EMM implementation) for each study site (Australia and England). The proportions of total observed time where pharmacists completed tasks with other clinicians or alone, and using different information tools (e.g. fixed computer, computer on wheels, laptop, paper) were also calculated for each site. To assess the extent to which the introduction of the EMM systems increased opportunities for pharmacists to engage with patients we examined changes in the time pharmacists spent in medication discussions with patients. 95% confidence intervals (CIs) of proportions were obtained using the large sample normal approximation. We compared the magnitude of pre- and post-EMM change in each task category for each site using z-tests for proportions with the level of significance set at $p<0.05$. We used both Bonferroni and Holm-Bonferroni methods for multiple testing, which showed no differences in results.

We also compared the relative impact of EMM implementation on pharmacists' task time distributions between the Australian and English sites, taking into account baseline differences in pharmacists' work. Bonferroni confidence intervals of these changes between two sites pre- and post-EMM are presented. Data analyses were conducted using SASV9.4.

Results

Work of hospital pharmacists at baseline in Australia and England

At baseline, pharmacists in Australia and England spent the greatest proportion of time on medication reviews. Pharmacists in both countries spent similar proportions of time on discharge medication reviews and in transit (Figure 1). However, Australian pharmacists devoted significantly greater time to social interactions (14.8% more than the English pharmacists), professional communication (11.2%), and medication discussions (8.9%), compared to their English colleagues after adjusting for multiple testing (Figure 1). English hospital pharmacists spent significantly more time on supply of medications (3.9% more than the Australian pharmacists), work organisation tasks (4.8%), medication review (5.5%) and history taking (11.8%).

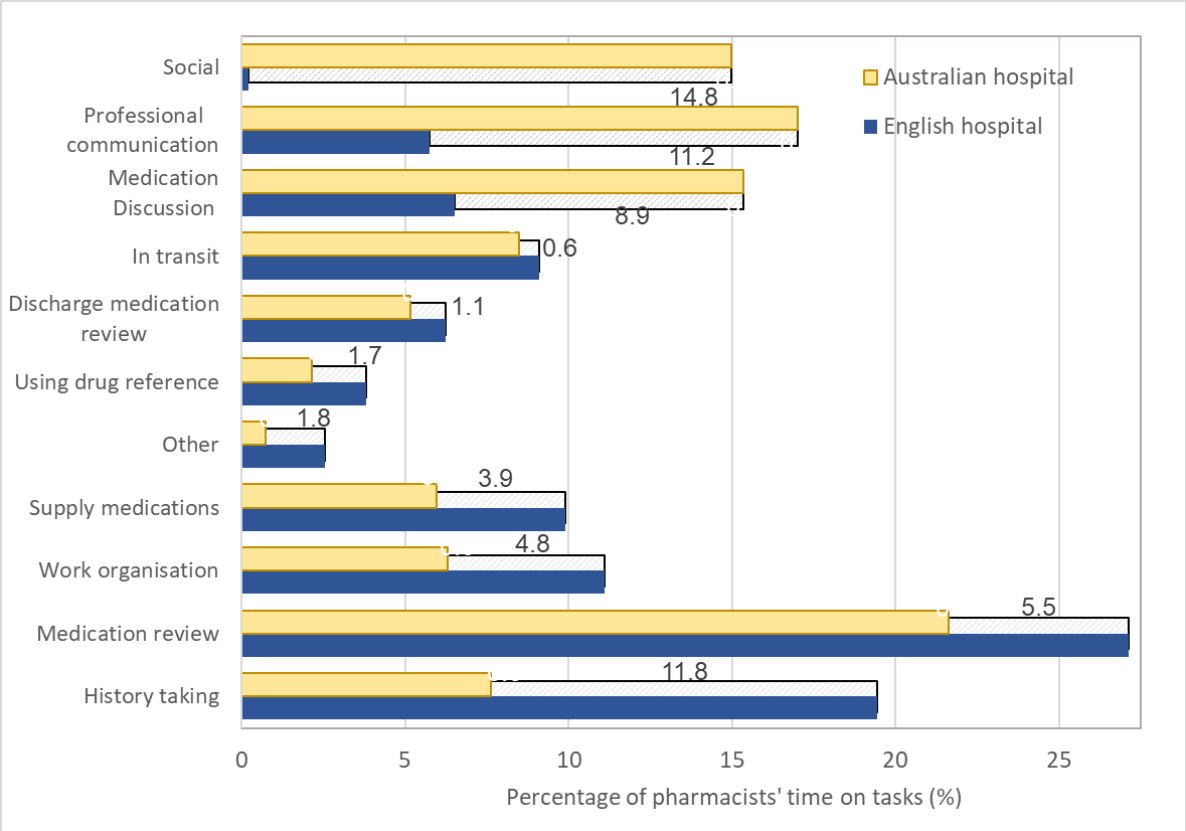

Figure 1: Task time distributions of English and Australian pharmacists and the absolute differences between the two sites at baseline

Changes in patterns of pharmacists' work pre- and post-EMM system implementation

Table 3 presents the proportions of time that pharmacists at both sites spent on different tasks pre- and post-EMM implementation. Overall, pharmacists in both countries spent the greatest proportion of time on medication reviews and this continued post-EMM. For English pharmacists, the next two most time-consuming activities were history taking and work organisation tasks. Whereas for Australian pharmacists these were professional communication and medication discussion. These three task categories consumed 57.6% of

English pharmacists' time at baseline and the same three tasks consumed 76.3% post-EMM. For Australian pharmacists their top three tasks consumed 54.0% of time at baseline and 77.2% post-EMM (Table 3).

Overall, pharmacists experienced low rates of interruptions at baseline (Australia 4.0 interruptions/hour, 95%CI 3.6-4.4; England 3.2/hour 95%CI 2.9-3.5) and the English pharmacists experienced a significant decrease post-EMM (2.5/hour 95%CI 2.2-2.8; $p<0.001$) with no change for the Australians.

Within hospital changes pre- and post-EMM

Pharmacists in both countries experienced a significant increase in the time allocated to medication reviews and history taking, and significantly less time in supply of medications post-EMM. For English pharmacists, a significant reduction in 'Other' tasks occurred, whereas the Australian pharmacists experienced a significant increase in time in these tasks. The time spent with drug references and on discharge medication reviews decreased in the English hospital but did not change in the Australian site (Table 3).

Following the implementation of the EMM systems there were no changes in the proportions of time that pharmacists in either country spent on medication discussions, work organisation, social interactions or in transit relative to their baseline rates.

Between-country comparisons post-EMM

We examined whether the implementation of the EMM systems had the same magnitude of impact at each hospital, taking into account differences between the English and Australian hospitals at baseline. We found that the extent of impact of the EMM for pharmacists in both countries was very similar (Table 3). However, for a small range of tasks there was a greater

impact on English pharmacists in terms of a significantly greater decrease in time spent on discharge medication review, use of drug references and 'Other' tasks.

Task	English Hospital % (95% CI)		Australian Hospital % (95% CI)		Difference in absolute changes between two sites pre and post EMM % (±95% CI′)
	Pre	Post	Pre	Post	
Medication reviews	27.1 (25.7-28.6)	↑ 33.8* (29.8-37.7)	21.6 (20.3-23.0)	↑ 27.5* (25.7-29.2)	0.8 (-6.1 - 7.7)
Professional communication	5.8 (3.2-8.2)	2.4- (2.1-2.8)	17.0 (11.9-22.1)	19.3 (15.5-23.2)	-5.7 (-15.6 - 4.3)
Medication discussion	6.5 (5.9-7.1)	6.3 (5.8-6.9)	15.4 (12.9-17.8)	15.5 (13.5-17.6)	-0.3 (-5.1 - 4.5)
Work organisation tasks	11.0 (9.3-12.9)	13.6 (10.8-16.4)	6.3 (5.0-7.6)	6.2 (5.7-6.7)	2.7 (-2.6 - 7.9)
History taking	19.5 (18.0-21.0)	↑ 28.9* (26.9-30.9)	7.6 (6.6-8.7)	↑ 13.3* (11.7-14.9)	3.8 (-0.7 - 8.4)
Supply medications	9.9 (9.1-10.7)	↓ 5.7 * (5.0-6.3)	6.0 (5.0-6.9)	↓ 3.1* (2.6-3.5)	-1.4 (-3.5 - 0.8)
Using drug reference	3.8 (3.4-4.2)	↓ 2.3* (2.0-2.6)	2.1 (1.8-2.5)	2.2 (1.8-2.5)	-1.6 (-2.5 - -0.6)*

Discharge medication review	6.3 (5.3-7.2)	↓ 1.9* (1.4-2.3)	5.2 (4.5-5.9)	4.5 (3.9-5.1)	-3.7 (-5.7 - -1.7)*
Social	0.2 (0.1-0.3)	0.1 (0.1-0.2)	15.0 (8.1-21.9)	7.0 (3.0-10.9)	8.0 (-3.5 - 19.4)
In transit	9.1 (8.3-9.9)	9.1 (6.2-12.0	8.5 (7.9-9.1)	7.9 (7.4-8.5)	0.6 (-3.9 - 5.0)
Other	2.5 (1.9-3.2)	↓ 1.1* (0.9-1.4)	0.7 (0.1-1.4)	↑ 2.2* (1.5-2.9)	-2.9 (-4.6 - -1.1)*

Table 3 Changes in pre-and post-EMM task time distributions and magnitude of changes from baseline

↓ ↑ Represent significant decrease or increase relative to the baseline proportion in that hospital

CI′: Confidence interval adjusted for multiple inferences

*Significant change within hospital between pre and post period after adjusting for multiple inferences

Note: Percentages do not add up to 100 as some tasks were undertaken at the same time.

Pharmacists' work alone and with others

Table 4 shows the proportions of time in which pharmacists engaged in tasks with others or alone, and how these changed post-EMM relative to the baseline in each country. At baseline, the greatest country difference was proportion of time spent working alone, which was considerably higher for English pharmacists compared to their Australian counterparts

(82.9% versus 66.8%). Following EMM implementation, Australian pharmacists increased the time they spent with all categories of people. However, there was no significant change for English pharmacists following the implementation of the EMM.

With Whom	English Hospital % (95% CI)		Australian Hospital % (95% CI)	
	Pre	**Post**	**Pre**	**Post**
Patient	7.3 (6.3-8.2)	8.2 (7.1-8.3)	5.6 (4.3-6.9)	10.2* (8.5-12.0)
Doctor	4.9 (4.4-5.4)	4.4 (3.9-4.8)	7.3 (5.4-9.3)	14.8* (11.4-18.2)
Nurse	3.5 (3.0-4.0)	3.2 (2.8-3.6)	6.5 (4.7-8.3)	12.4* (9.0-15.8)
Alone	82.9 (78.9-87.0)	92.0 (85.9-98.1)	66.8 (59.3-74.3)	63.4 (58.7-68.1)

Table 4 Proportion of time hospital pharmacists spent with others and alone pre- and post-EMM

*Significant change within hospital between pre and post period after adjusting for multiple inferences

Note: Percentages do not add up to 100 as pharmacists sometimes worked with people from more than one category at the same time.

At baseline, there were country differences in the rates at which pharmacists engaged in medication discussions with patients (England 5.9% versus 18.0% for Australia). Post-EMM, English pharmacists increased their time engaged in medication discussions with patients to 10.8% (p=0.01), but there was no significant change in the Australian rate (27.2%; p=0.09).

Resources used to complete work

Pharmacists at both hospitals experienced significant shifts in the resources use post-EMM (Table 5). Tasks using computers increased substantially (Table 5). In England, pharmacists decreased their use of fixed computers, with a dramatic increase in task time spent with mobile devices. Australian pharmacists increased the proportion of time using fixed and mobile devices post-EMM. As would be expected, time spent in tasks involving paper nearly halved in both hospitals.

Resource	**English Hospital** **%** **(95% CI)**		**Australian Hospital** **%** **(95% CI)**	
	Pre	**Post**	**Pre**	**Post**
Fixed computer	19.5 (17.4-21.6)	8.3* (7.2-9.5)	12.1 (10.7-13.6)	17.1* (15.6-18.7)

Paper	70.1 (67.2-73.0)	40.0* (37.7-42.3)	39.8 (37.2-42.4)	20.7* (18.9-22.6)
Mobile computer	0.3 (0.1-0.4)	54.7* (52.1-57.3)	1.4 (0.6-2.1)	20.7* (18.9-22.6)
Face-to-face	18.5 (16.9-20.0)	15.8 (14.4-17.2)	32.1 (26.4-37.8)	36.2 (31.8-40.6)
Phone	7.1 (6.3-7.9)	6.5 (5.7-7.4)	4.0 (3.3-4.8)	5.7* (4.8-6.6)

Table 5 Proportion of tasks which involved the use of different resources pre and post EMM by hospital site

*Significant change within hospital between pre and post period after adjusting for multiple inferences

Note: Percentages do not add up to 100 as multiple resources might be used at the same time.

Discussion

The central aim of this study was to investigate whether EMM implementation in two countries was associated with changes in pharmacists' patterns of work. We found that in both countries this was the case. Importantly, our results showed that despite some significant differences in the task time distributions of Australian and English pharmacists at baseline, the introduction of EMM impacted the same areas of work and had a similar

magnitude of effect, with a few exceptions. Medication review and history taking, constituted the greatest proportion of pharmacists' work in both countries, and significantly increased, while time in supply of medications decreased post-EMM. Given that EMM systems are designed to facilitate comprehensive and efficient review of patient information, this result was somewhat unexpected. There are very few studies against which to compare our findings. A small Australian quantitative study[20] compared the work of pharmacists on wards with and without EMM and reported that pharmacists using the system spent a greater proportion of their time on medication review tasks compared to colleagues on wards without EMM, mirroring our finding. The increased time spent post-EMM in medication review may be due to several factors. Finding information for medication review purposes may not be as easy and efficient as was the case with paper charts, with multiple screens to click through to find necessary information. EMM systems may increase the volume of information available for pharmacists to review and thus require a greater time commitment. Results from interviews with pharmacists supports this latter hypothesis. Australian paediatric pharmacists expressed feelings of increased stress due to the additional information available within an EMM system and their perceived increased responsibility to review all this information.[21]

A further possibility for increased time devoted to reviews post-EMM is suggested by the findings of Burgin and colleagues[15] who interviewed UK hospital pharmacists. Post-EMM, these pharmacists reported a substantial increase in documentation by pharmacists in the EMM. They attributed this to the ease of documenting in the EMM system, a desire to gain added legal protection for themselves, as well as to contribute to clinical team communication. However, senior UK pharmacists perceived that this behaviour was more likely among junior pharmacists and may have been a strategy to avoid direct communication with clinical staff due to a lack of confidence. Burgin et al[15] concluded that additional training in verbal communication and negotiation for pharmacists would be beneficial. Our

quantitative findings that English pharmacists halved the time they spent in professional communication following the introduction of the EMM (from 5.8% of their time to 2.4%) and experienced overall low levels of inter-professional communication, both pre and post EMM introduction, lends additional support to this recommendation.

Further potential explanations for factors contributing to the increased time that pharmacists spent in medication reviewing tasks is the time taken to correct new types of errors facilitated by EMM systems. An early study[22] in the US investigating the impact of EMM on pharmacists' work in an outpatient setting found that following system implementation pharmacists spent increased time correcting prescriptions and problem-solving. Lo et al[13] also reported that EMM pharmacists spent a greater proportion of time clarifying medication issues compared to pharmacists on wards without EMM in an Australian hospital. These additional activities will be incurred during the medication review process and thus may contribute to overall increased time in this task category.

An attribute of EMM systems is the ability to easily communicate information across clinical teams, hence a decrease in other forms of direct communication, such as professional communication or medication discussions, might be expected post-EMM. The Australian pharmacists at baseline had substantially higher rates of interaction with other professionals (17.0% versus English pharmacists 5.8%) and maintained this level of professional communication post-EMM. An Australian qualitative study[21] found that post-EMM implementation, pharmacists reported being relied upon by clinical staff to answer questions about the use of EMM and to provide on-the-spot training. They perceived this as a substantial increase to their workloads. Similar concerns regarding increased responsibilities as informal EMM trainers have been noted by UK hospital pharmacists.[15] This informal

training role is a likely contributor to the significant increase Australian pharmacists experienced in the time spent with doctors post-EMM.

A promoted benefit of EMM systems is to free-up a proportion of pharmacists' time to allow more time for patient counselling. For the English pharmacists, the proportion of time spent in medication discussions with patients almost doubled from 5.9% to 10.8% post- EMM. Australian pharmacists experienced no equivalent significant change, however, at both baseline and post-EMM they allocated a much greater proportion of their time to this task (18.0 pre- and 27.2% post-). We found a substantial uptake in the use of mobile computer devices by the UK pharmacists, considerably more than for the Australians, which may have facilitated increased interactions with patients. A qualitative study[15] using focus groups with 38 UK pharmacists to investigate the impact of EMM systems on their work, reported that a major concern of pharmacists was a reduction in contact with patients due to the removal of the paper chart from patients' bedsides and a relocation of pharmacists' work to central computer locations. The availability of mobile devices found in our current study may have guarded against this problem to an extent.

No previous studies have quantitatively compared pharmacists' work practices across countries. While we found pharmacists in England and Australia had a common central work task of medication review, which consumed around 25-30% of their time, there were substantial differences in other task time distributions. Overall, Australian pharmacists were substantially more engaged with clinical teams with a high proportion of their time spent in professional communication, medication discussions and social interactions. This was reinforced by our findings that around 40% of all Australian pharmacists' work time involved tasks with others, and 30% of tasks involved face-to-face communication. In contrast, English pharmacists spent over 80% of their time working alone, a reflection of their lower

levels of time spent in professional communication, medication discussions and extremely low levels of social interactions. Thus, there appear to be some fundamental differences in the way pharmacists in the two countries engage in their work responsibilities despite quite similar training programs and roles in public hospitals.

Limitations

It is possible that some of the differences noted between the English and Australian results were due to different interpretations or application of the work task classification. We sought to guard against this through the use of common training procedures for the observers, joint teleconferences to discuss pilot observations, and the use of the same standard training scenarios. However, it was not possible to conduct inter-rater reliability tests between the observer teams in the two countries due to distance. Differences in the application of the classification could contribute to the differences observed in the baseline profiles of the two countries, but would be unlikely to account for changes noted pre- and post-EMM implementation which was the central focus of the study.

While we found a significant increase in time spent in medication review post-EMM we were unable to determine from our data whether pharmacists completed a greater number of medication reviews post-EMM, which would provide an indication of whether pharmacists spent more time overall in this work task or were able to process more patients in the same time and therefore were more efficient than at baseline. This could be considered in future studies.

Authors' Contributions

All authors were involved in the conceptualisation and detailed design of the study. SS, EL, MP, BH were involved in observer training and data collection, LL performed the analyses, JIW prepared the draft manuscript and all authors participated in the interpretation and revision of the final manuscript.

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Authors' Contributions

All authors were involved in the conceptualisation and detailed design of the study. SS, EL, MP, BH were involved in observer training and data collection, LL performed the analyses, JIW prepared the draft manuscript and all authors participated in the interpretation and revision of the final manuscript.