Using network analysis to explore factors moderating the implementation of a medication review service in community pharmacy

Background

One of the major challenges currently facing health care systems is the lack of translation of evidence-based services into routine practice of health care professionals. It has been suggested that evidence-based practices in health care can take on average 17 years to be implemented, and that only a small percentage of original research is finally translated into routine practice.[1, 2] In the last decade implementation science has focused on addressing this complex science-to-practice gap, through the scientific study of methods to promote the uptake of research findings into routine health care.[3, 4] A range of frameworks, theories and models have been developed in an attempt to understand the complexity surrounding implementation. These include: (1) Process models describing or guiding the implementation process through a number of implementation stages, (2) Evaluation frameworks guiding the evaluation of the implementation success and (3) Determinant frameworks, classic theories, and implementation theories describing and explaining influences on implementation outcomes.[5] Widely known determinant frameworks such as the Consolidated Framework for Implementation Research (CFIR) and checklists such as the Tailored Implementation for Chronic Diseases (TICD),[6, 7] describe a core of implementation factors or determinants distributed across different domains. They are hypothesised to moderate the implementation of evidence based services [8] and assume that there are relationships with implementation factors within and across domains.[5]

Different nomenclatures (i.e. constructs, implementation factors, determinants of practice, determinants of implementation, etc.) are used to describe the elements that influence implementation, often creating confusion.[8] In this paper, the term "implementation factor" is used to refer to any element that moderates, either positively (i.e. facilitator) or negatively (i.e. barrier), the

implementation of an evidence-based service.[8] Researchers have identified barriers and facilitators in numerous health care settings for the implementation of different health services and evidence-based innovations.[9-15] These have usually been explored focussing on a limited number of implementation factors, and assuming simple causal relationships.[16, 17] This traditional way of identifying implementation factors as either single barriers or facilitators may be considered simplistic as they can often have changeable, pluralistic and even opposing meanings.[18] Rather than linear relationships between implementation factors, it is more plausible that several implementation factors across different domains interact, making it difficult to determine and predict their cause and effect relationships.[6, 7, 16] A systematic review of reviews aiming at synthesising the causes of the evidence to practice gap in primary care settings concluded that despite their importance, interrelationships between implementation factors are usually not considered.[19] It could be hypothesised that implementation factors and their causal relationships can vary according to the particular characteristics of an organisation, service being implemented and phase of the implementation process. However, some fundamental implementation factors may be present across all services and organisations.

The so-called ´science-to-service´ gap is a common phenomenon across health care disciplines, including pharmacy. Concurrently as the pharmacy profession, has a vision of being more patient-centred, there is some urgency to closing this gap.[10] Evidence on the positive clinical, humanistic and economic effects of professional pharmacy services has been generated, with promising results in improving patient care.[20-26] Within these services, Medication Review with Follow-up (MRF) has proven to be one of the most cost-effective community pharmacist-led interventions.[20, 22, 25] However, its broader implementation into routine practice of pharmacists is limited and a deeper understanding of the factors affecting its large-scale implementation is needed. It has been suggested network analysis can assist in addressing this challenge.[27] To the best of our knowledge, no studies have established the cause and effect relationships between implementation factors involved in an implementation effort using approaches such as network analysis. Expanding the knowledge of these

causative relationships would greatly enhance the design of tailored strategies to ensure optimal implementation of programs, interventions and innovations such as professional pharmacy services.

This study aimed to explore the factors associated with the implementation of MRF in a community pharmacy setting in Spain. The objective was to examine how a network of implementation factors and the position of each factor within this network structure influenced service implementation. Cause and effect relationships between implementation factors were explored.

Methods

Study design

The current research used a mixed methods approach consisting of participant observation, semi-structured interviews, collective discussion and document analysis alongside a 12-month effectiveness-implementation hybrid study.[28]

Context and setting

There are approximately 22,000 community pharmacies in Spain, with an average of 2.4 pharmacists per pharmacy and an average of 2,117 patients per pharmacy.[26] Community pharmacies in Spain are private health establishments of public interest, only owned by pharmacists (with a maximum of one pharmacy per pharmacist). Furthermore, the state government controls the opening of new pharmacies and chain stores are not allowed.[29] In the last few years, the community pharmacy setting in Spain, encouraged by official pharmacy professional organisations, is evolving towards the provision of patient-centered services. Medication review with follow-up service has been prioritised for its implementation by professional organisations, as it has proven to improve clinical outcomes and medication management, being a highly cost-effective intervention.[22]

Innovation to be implemented: Medication review with follow-up service

Medication review with follow-up is a professional pharmacy service, where the pharmacist identifies patient's drug related problems in order to prevent and resolve negative clinical outcomes related to medicines. MRF consists of seven stages, through which the patient's pharmacotherapy is assessed and a care plan is produced.[30]

Study participants

Pharmacists working in community pharmacies were enrolled in a national program for the implementation of MRF service.[28] Community pharmacies in each of the 11 participating Colleges of Pharmacists in Spain were invited to participate. The criteria for the inclusion were: (1) Pharmacies whose user population would include patients with an age equal or greater than 65, using polypharmacy (5 or more medications, used continuously for at least 6 months) and (2) Pharmacies whose owner expressed their desire to implement the MRF service and allowed pharmacist providers to attend training for the provision and implementation of the service. Sample size was established at a maximum of 14 pharmacies per province, the maximum of pharmacies that a practice change facilitator could support. This number was based on previous research.[31]

Implementation strategy

The Framework for the Implementation of Services in Pharmacy (FISpH) a pharmacy discipline specific model adapted from previous implementation frameworks was used.[32] It conceptualises the implementation of professional services through a number of implementation stages, ranging from exploration to sustainability. Across each stage of the implementation process, it describes three fundamental components of influence to be considered: implementation factors, strategies and evaluations.

Three researchers reviewed the CFIR framework, the TICD Checklist and the Core Implementation Components[6, 7, 33] to identify the implementation factors relevant to the study setting (community pharmacy) and the MRF service. Forty-three implementation factors were identified (Additional file 1). The implementation factors were categorised across four different domains derived from CFIR. [6] These domains were: (1) professional service (i.e. the characteristics of the innovation to be implemented), (2) pharmacy staff (i.e. the characteristics of the individuals involved in the implementation of the innovation), (3) pharmacy (i.e. the setting in which the innovation is implemented) and (4) local environment (i.e. the local setting of the pharmacy in which the implementation takes place).

Data collection

As a part of the implementation program, practice change facilitators (PCF) were used to facilitate the MRF service implementation at the pharmacies and for data collection. PCFs were selected and employed by the participating Colleges of Pharmacists, with the research team providing a job description which included a set of minimum requirements and a proposed interview structure for the applicants. The PCFs had to be graduates in pharmacy with professional experience in community pharmacy. They were required to know the MRF service protocol, have optimal communication and teamwork skills and appropriate bibliographic resources management skills.

Data collection was undertaken on-site in each participant pharmacy on a monthly basis by 12 practice change facilitators.[31] A participant observation guide was designed based on the 43 implementation factors previously identified by the research team. [7] This guide was designed to allow PCFs to systematically identify and individually evaluate each pharmacy, identifying the implementation factors, operating as barriers or facilitators, and their probable cause and effect relationships. All PCFs used the same descriptive list and participant observation guide.

Prior to the start of the program, PCFs received specific training on the study processes and data collection. The research team provided continuous training and feedback to the PCFs for the duration of the study through face-to-face meetings. The PCFs were supervised through online meetings every three weeks by the research team with their progress being monitored. PCFs made an initial visit to their allocated pharmacies using the participant observation guide and independently interviewed each participant pharmacist face to face in order to gain a deep understanding of relevant implementation factors. Post visit, the PCF analysed the data collected, linked each implementation factor operating as barrier or facilitator with their probable cause and transferred the information into a database. This process was undertaken individually for each pharmacy. One of the researchers (BPE) reviewed the pharmacy data on a weekly basis for quality assurance purposes. Implementation factors were coded on completion of the project by the same researcher (BPE). The coding and data were checked by a second researcher (VGC) and differences resolved via discussion. Finally, researchers validated and grouped together all the data from participant community pharmacies.

Data analysis and management

A network analysis to model relationships between implementation factors was undertaken using NodeXL Pro.[34] Network analysis[35, 36] allows the investigation of systems by representing them as networks where entities (nodes) are connected by relationships (edges). In this study, implementation factors are nodes, and edges represent the relationships (e.g. influence) between implementation factors. Network analysis presents a potential approach of identifying the degree of implementation factors´ influence and associations, based on their centrality metrics and position within the network (see Additional file 2 for metrics definitions their application to the study). Two independent network analyses were performed, one based on implementation factors operating as barriers and a second on implementation factors operating as facilitators. Networks characteristics including number of nodes and edges, edge direction, maximum number of edges per node, graph density, connected components, cause and effect relationships (determined by edge strength), size, reciprocity, centrality

measures (betweenness centrality, closeness centrality, eigenvector centrality, in-degree and out-degree) were calculated to better understand the topology and function of the networks. For most of the visualizations, a Harel-Koren Fast Multiscale layout[37] was used.

Centrality measures such as in-degree, out-degree, closeness, betweenness and eigenvector are usually used to assess the importance of a node in a given network though different measures have different meanings.[38] The details how each network measure is interpreted in this study is outlined in Additional file 2. In the network visualization, the node size is proportional to closeness centrality measure of the implementation factor. In addition, the colour of the edge indicates the direction of the relationship (reciprocity). Dark blue arrows represent reciprocal cause and effect relationships and light blue depicts non-reciprocal causal relationships. The thickness of the edges symbolises the weight of the relationship (edge strength).

The StaRI (Standards for Reporting Implementation Studies) recommendations have been followed.[39]

Ethics

The project was approved by the Ethics and Research Committee of the Virgen de las Nieves University Hospital in Granada, Spain (Approval number 13/C-11). A written information sheet was provided and informed consent was obtained from the participant pharmacists.

Results

Study sample

The study was undertaken in 135 community pharmacies with 222 pharmacists being enrolled (MRF service providers). Of the 135 community pharmacies enrolled, 61.1% were located in an urban area, 21.4% in a semiurban area and 17.5% in a rural area. There was an average of 2.7 pharmacists (SD: 1.23) and an average of 1.9 (SD: 1.46) of other staff per pharmacy.

Networks compositions

The overall metrics for the extracted networks are presented in Table 1. The visualization of the two network graphs including implementation factors (nodes) and the relationships (edges), is provided in the Additional file 3. The centrality measures for each implementation factor for both networks are represented in histograms in the Additional file 4. Both network structures show all implementation factors were interconnected, implying great complexities on how the factors moderated the implementation of the MRF service. A large area of blue, purple and green nodes tends to be located in the centre of both networks, signalling implementation factors across different domains (i.e. professional service, pharmacy staff, pharmacy, local environment) were closely interrelated and their connections accounted for most of the existing links. In both networks, the graph density (0.2 for the barriers network and 0.3 for the facilitators network) indicates the existence of dense networks, with implementation factors being proximate to each other.

Table 1: Networks' metrics

METRIC	BARRIERS NETWORK	FACILITATORS NETWORK
Nodes	**43**	**42***
Edges	**369**	**456**
Edge direction	**Directed**	**Directed**
Maximum number of edges per node	**102**	**57**
Graph density	**0.2**	**0.3**
Connected Components	**1**	**1**
Average In-Degree (SD)	**8.6 (7.4)**	**10.9 (7.8)**
Median In-Degree	**8.0**	**9.5**
Average Out-Degree (SD)	**8.6 (6.3)**	**10.9 (6.0)**
Median Out-Degree	**7.0**	**9.0**
Average Betweenness Centrality (SD)	**29.3 (47.5)**	**25.8 (29.4)**
Median Betweenness Centrality	**12.6**	**13.5**
Average Closeness Centrality (SD)	**0.014 (0.002)**	**0.015 (0.002)**
Median Closeness Centrality	**0.014**	**0.015**
Average Eigenvector Centrality (SD)	**0.023 (0.011)**	**0.024 (0.010)**
Median Eigenvector Centrality	**0.023**	**0.023**
***The implementation factor *pharmacy/pharmacist withdrawal* was not identified in the facilitator's network.**		

Implementation factors hindering the service implementation: Barriers

The implementation factors with highest overall centrality measures were *time, motivation, recruitment, individual identification with the organization* and *personal characteristics of the pharmacists.* These five implementation factors were identified as the most critical with similar scores for closeness, betweenness, eigenvector and in-degree centrality properties.

The network with the most important implementation factors according to their closeness centrality scores (i.e. showing a great influence on other factors) is shown in Figure 1. Three of these implementation factors were in the domain 'professional service' (*time, recruitment* and *program methodology*), three were in the domain 'pharmacy staff' (*personal characteristics of the pharmacists, motivation* and *individual identification with the organization*) and two factors in the domain 'pharmacy' (*leadership* and *characteristics of the pharmacy*).

Figure 1. The 20% most important barriers as shown by high closeness centrality score.

There were additional implementation factors with high out-degree scores, which included: *personal characteristics of pharmacists* and *pharmacy, personal circumstances of the pharmacists, previous experience in the provision professional services, workflow, leadership, complexity and individual identification with the organisation*. Based on their out-degree, these implementation factors seemed critical, considering their direct influence on others (i.e. causing other barriers). A histogram of all the implementation factors with their centrality measures is provided in Additional file 4. As both in-degree and out-degree centrality distributions follow power law trend, removing the top well-connected nodes would result in removing the most critical implementation factors operating as barriers (in-degree) and their causes (out-degree).

In this network*, Time* (i.e. the amount spent by the pharmacist in the provision and implementation of the service) was the most critical implementation factor, as shown by all five centrality scores. Based on degree centralities, *time* was a critical barrier as well as a cause for others. It was a factor

that also had a high closeness centrality, meaning that *time* had great influence on many other implementation factors. Its high betweenness (which reflects the extent to which an implementation factor acts as a bridge or gatekeeper, to control the influences flowing through it) suggests that removing *time* (i.e. addressing *time* as a barrier) would disrupt the connections between other implementation factors, reducing the disseminating influences on the network. The main causes contributing to the lack of time were identified as *workflow, characteristics of the pharmacy and personal circumstances of the pharmacists* (Figure 2). The weights of all the implementation factors contributing to the appearance of the barrier *time* are presented in the Additional file 5 (Table 1).

Figure 2. *Time* as a barrier: All causes.

Three hundred and sixty-nine different cause-and-effect relationships between implementation factors were identified. Forty-eight of these accounted for more than 60% of the total amount of interrelationships identified (Figure 3). The most important cause and effect relationships (indicated by the edge strength) were: *workflow-time (102); characteristics of the pharmacy-time (57); personal characteristics of the pharmacists-motivation (56); time-motivation (52); personal circumstances of the pharmacists-time (47); personal characteristics of the pharmacists- external support (46); personal characteristics of the pharmacists- recruitment (46).*

Figure 3: The 20% most important cause and effect relationships (edge strength).

Implementation factors facilitating the service implementation: Facilitators

The implementation factors with highest centrality scores were *motivation, individual identification with the organization, beliefs, adaptability, recruitment, external support* and *leadership.* These seven implementation factors appeared important within the network according to the following measures: closeness, betweenness, eigenvector, in-degree and out-degree centrality properties. The network in figure 4 shows the most important implementation factors with high closeness centrality score for this network. A histogram of all the implementation factors with their centrality measures is provided in

Additional file 4. The domains including these implementation factors were 'Professional service', 'Pharmacy staff' and 'Pharmacy'.

Figure 4. The 20% most important facilitators as shown by high closeness centrality score.

Of the factors with highest closeness centrality score, two belonged to the domain 'professional service' (*adaptability* and *recruitment*), four factors in the domain 'pharmacy staff' (*motivation, individual identification with the organization, beliefs* and *personal characteristics of the pharmacists*) and one in the domain 'pharmacy' (*external support*).

Motivation (i.e. interest and enthusiasm shown by the pharmacy staff when implementing the service) was the most important factor operating as a main facilitator for the successful implementation of the MRF service. The main factors contributing to motivation were: *external support, individual identification with the organization, beliefs, personal characteristics of the pharmacists, knowledge, observability* and *recruitment* (Figure 5), accounting for the 60% of the causes. The weight of all the causes contributing to the appearance of the facilitator *motivation* is presented in Additional file 5.

Figure 5. *Motivation* as facilitator: All causes.

Four hundred and fifty-six different cause-and-effect relationships were identified. Fifty-two of these accounted for 50% of the total number of interrelationships identified (Figure 6). The most important cause and effect relationships (according to edge strength) were: *external support-motivation (57); characteristics of the pharmacy-structure (42); location of the pharmacy-demographics (40); external support-knowledge (39); motivation- knowledge (38); personal characteristics of the pharmacists-knowledge (37); motivation- individual identification with the organization (34); individual identification with the organization-motivation (31); motivation-recruitment (31); GPs' knowledge and beliefs- network with GPs (29); previous experience with GPs / other healthcare professionals- network with GPs- (26).*

Figure 6. The 20% most important cause and effect relationships (facilitators' edge strength).

Discussion

Network Analysis is a technic widely used to model relationships between entities [40, 41]. It has been applied in numerous disciplines including pharmacology, sociology, psychology, construction, economics, and engineering amongst others . Nevertheless, network analysis has successfully proven to be valuable in identifying important implementation factors moderating the implementation of a MRF service and the critical interactions underlying those factors.

The measures of centrality for the whole network and for individual implementation factors can be utilised to make relative comparisons of their importance. A combination of closeness centrality, betweenness centrality, eigenvector centrality, in-degree and out-degree were used to establish the relative importance of each implementation factor.[36] According to these measures, motivation and individual identification with the organisation seemed critical factors in both hindering and facilitating the MRF implementation, supporting their dynamic nature described previously.[19] The centrality measures allowed not only the identification of critical factors for the implementation of a MRF service, but also identifying causal relationships between them, responding to the call in the literature to address this evidence gap.[19] This type of research seems fundamental for the advancement of the pharmacy profession, as it can facilitate the development of tailored strategies for the implementation of professional pharmacy services.

Implementation factors hindering the service implementation: Barriers

Interestingly, the barriers' network had only one component, with no subgroups of implementation factors isolated within the network. This suggests that all implementation factors were interconnected, reflecting the complexity of their interrelationships. The network exhibited high density, signalling that implementation factors were interrelated, well connected and highly influenced each other.[42]

In this network, five implementation factors were identified as the most critical for service implementation according to a range of centrality measures. Lack of *Time* appeared as the most crucial and important implementation factor, with high closeness, betweenness, eigenvector and in-degree centrality properties. It was shown to be highly influenced and frequently caused (as shown by the high edge strength) by *workflow, characteristics of the pharmacy and personal circumstances of the pharmacists*. To assist a more effective implementation programs, tailored strategies need to be developed to address these critical causes.[19] For example, a PCF could, with the support of the pharmacy staff, provide a predefined *workflow*, which would then be adapted to each specific pharmacy. Redesigned workflows with structured and organized tasks have successfully been tested in pharmacy, releasing staff for service provision and even allowing their specialisation as service providers.[43] Setting priorities and goals in regards to work performance and outcomes, monitored through key performance indicators, should be considered. This could also contemplate the assignment of individual specific patients to other co-worker when a service provider is absent (*personal circumstances of the pharmacists*). The addition of a specific computer used only for the provision service or a change in the pharmacy infrastructure (*characteristics of the pharmacy*), with investment and maintenance costs, need to be contemplated if professional services such as MRF are to become part of usual practice.[13, 44] This aligns with previous research conducted in Australia, in which the pharmacy layout appeared critical to support service implementation.[45] The layout currently used by many pharmacies is designed for medicines dispensing and does not easily accommodate service provision. For example, some participant pharmacies did not have a private consultation room, which in other pharmacies appeared to promote more optimal workflow and facilitated the provision of the service. Nevertheless, implementation factors operating as barriers with high in-degree scores (such as *recruitment*, *motivation* or *time*) may have many different causes. These may represent barriers which are more complex and difficult to overcome. This finding highlights that appropriate multi-faceted strategies are needed to overcome the challenge of effective implementation, reflecting its multifactorial nature.[8]

Lack of *motivation*, a critical implementation factor which also had a high out-degree (i.e. major cause for the appearance of other barriers), appeared to be caused by lack of *time* and by *personal characteristics of the pharmacist*. These findings are not surprising and align with previous research, suggesting a potential link of personality traits with certain professional roles. A study conducted in Canada, aimed at investigating relationships between personality traits (according to the Big Five Inventory, BFI) and the uptake of advanced practice opportunities by pharmacists. The authors found a positive relationship of extraversion, agreeableness and openness with the provision of advanced pharmacy services.[46] A recent study conducted in New Zealand, aimed to explore whether BFI individual characteristics of graduating pharmacy students were associated with engagement in patient-centred pharmacy services. Findings also suggested participants with higher scores on conscientiousness, agreeableness and extraversion had a greater interest to engage in patient-centred pharmacy roles.[47] It is now common practice for employers in many industries to identify the personality profile of their employees, in order to assign more appropriate tasks to each member of their staff. A similar concept could be applied in pharmacy, with those pharmacists scoring higher in personality traits associated with better people interaction, being allocated to service provision. Previous research has stressed more emphasis should be put on selecting practices and providers that are most motivated to deliver services.[9] Training delivered to service providers before and during the implementation effort also needs to incorporate an element of motivation towards service provision.[41] However, stablishing an environment that facilitates employees' self-motivation might be more effective long-term.[48]

In addition, patient *recruitment* was an important barrier caused by 28 different implementation factors (as shown by its high in-degree). These included a perception of patient distrustfulness (*patients' knowledge and beliefs*); the pharmacist was apprehensive to undertake an interview with the patient (*personal characteristics of the pharmacists*); a lack of time allocation to service offering and provision (*time*); or inappropriate skills when communicating with patients during service offering (*communication with patients*). Nevertheless, these results align with findings from a systematic

review which identified recruitment and retention was the most reported barrier for the implementation of evidence-based interventions.[9] Another systematic review also found a high influence of patient acceptance, demand and resistance on the implementation of innovations in community pharmacy settings.[15] Authors recommended the development of more comprehensive stakeholder engagement strategies to increase patient awareness and acceptance of services through emphasis of intended benefits.[15]

High out-degrees were observed for some implementation factors, which indicated these highly influenced the appearance of many different barriers. The impact of some unmodifiable factors (i.e. *personal characteristics of pharmacists* and *pharmacy, personal circumstances of the pharmacists*) and *workflow* have already been discussed. However, there were further implementation factors subject to be considered. The position and centrality scores of the implementation factor *complexity* indicated the difficulty perceived by pharmacists with the innovation to be implemented. Complexity is frequently reported in the implementation science literature as a hindering factor.[15] The implementation of innovative and complex services such as MRF, require significant reorientation on the traditional role of pharmacists and reflects a clear paradigm shift from existing practices. These results align with a recent adaptation of the CFIR to pharmacy, which suggested less complex or multi-faceted services seem to be more easily implemented than more complex ones.[49] Therefore, the balance between the implementation effort and its relative added value should be carefully assessed in advance. This could also influence another relevant implementation factor, *previous experience in the provision of services*. Providing a service over time not only allows to build up experience and expertise, but also its adaptation over time. Despite MRF being one of the pharmaceutical services defined in the Spanish National Strategic Consensus for implementation of pharmaceutical care, its broader implementation is limited, mainly due to lack of government funding.

The commitment, involvement and responsibility of the pharmacy owner or manager towards implementing the MRF service seemed crucial (i.e. *leadership*). Effective *Leadership* that supports

implementation is a critical concern in the health care literature, with implementation and leadership theories emphasizing its importance in supporting implementation efforts.[50] Particularly in pharmacy, it has been described as a key factor to ensure continuity of service delivery.[51] It has been suggested effective *leadership* is required to create the appropriate organizational culture and climate for the adoption of the service.[8] Effective leaders should be proactive, knowledgeable, supportive, and perseverant with the implementation effort. [50] Previous research shows favourable *leadership* has been stablished by: (1) taking ownership of the implementation effort once the service has been adopted, (2) prioritisation, (3) continuous monitoring and feedback through regular staff meetings and (4) rearranging the workflow to release the service provider from other duties in the pharmacy and allow service provision (*Workflow*). An alternative strategy would be to nominate an internal champion in the pharmacy to act as an implementation leader.[6, 52] *Individual identification with the organisation* related to how each pharmacy staff perceived the organization (i.e. pharmacy) and their commitment and alignment to its strategic direction. This individual identification can affect the willingness of the pharmacy staff to fully engage in implementation efforts or even provide the service. Although there is limited evidence on the impact of this implementation factor in healthcare settings including[15] community pharmacy, it has been suggested it should be considered when evaluating the influence of implementation leaders on implementation efforts.

Implementation factors facilitating the service implementation: Facilitators

The facilitators network also had a high density with one single component, suggesting that the implementation factors within this network were also interconnected. The most critical factors could be clearly identified using a combination of centrality scores. Some of these (e.g. *motivation*, *recruitment* and *individual identification with the organisation),* also appeared to have the highest centrality scores in the barriers network. These findings support the hypothesis that implementation

factors are a dynamic concept, operating as both barriers and facilitators depending on the implementation context.[8]

Causative relationships between implementation factors operating as facilitators were explored. For example, the high *motivation* amongst service providers seemed to be mainly caused by *external support* (i.e. measure to which a pharmacy receives the external support required for practice change)*, individual identification with the organization, beliefs* (i.e. attitude and importance given to the service implementation by each staff)*, personal characteristics of the pharmacists, knowledge* (i.e. training and knowledge on the provision of the service), *observability* (i.e. level up to which the pharmacists perceive the benefits of providing the service) and *recruitment.* Reinforcing all these causative factors thrugh tailored strategies might be a key for successful implementation. In this study, an intensive initial training was provided by the research team before the beginning of the implementation effort. This was complemented with and ongoing training and support by PCF, through various methods which included individualised on-site, telephone and videoconference support and group workshops with other implementers. PCF also provided continuous reinforcement and feedback on the service's progress and outcomes, increasing its *observability* and staff *beliefs*. This reflects one of the many roles PCFs adopt to support and coach the pharmacist through the implementation effort.[53, 54] It is worth mentioning the relevance of *adaptability* (i.e. level to which the service has been adapted to or modified, to cover the needs of the local environment in which the service is being implemented) and how adaptations to the service protocol were made to facilitate its implementation. Service adaptation is given high relevance in the literature and has been described as essential to ensure the long-term sustainability of evidence-base interventions.[55, 56] However, there is uncertainty on how adaptation and fidelity (i.e. the degree to which an intervention or program is delivered as intended) should be balanced. Many services come in packages with clear guidelines on how they should be provided, but do not always address the issue of adaptation and modification to the implementation context, which allows maximum implementation and sustainability.[57] Although adaptation and fidelity appear to be opposing concepts, they can be applied simultaneously.[57] The importance of

fidelity relies on the capacity to deliver a service following a consistent approach, and it is associated with better program outcomes.[16] Identifying essential core components of the service may provide an opportunity to adapt it to the local context in which it is implemented, without compromising its effectiveness.[58] In this study, PCF closely monitored the fidelity of the service to ensure its main core components were being delivered.

Limitations

The data collected in this study was highly dependent on the identification of implementation factors by PCF. Although they were pharmacist who were trained on implementation theory, models, and evaluation methods, most of them had not performed this role previously. To minimise this limitation appropriate management structures were employed and the data provided on a weekly basis was systematically analysed.

The analysis did not allow to relate implementation factors to specific pharmacies or pharmacists. Additionally, it may be hypothesised that the influence, type, frequency and number of implementation factors may vary depending on the stage of implementation and service to be implemented. Finally, implementation factors related with the external context (e.g. policy, legislation, economic climate) were not considered in this study. Future research could address these issues.

Conclusion

Network analysis has been proven to be a useful analytical technique to be used in identifying networks of implementation factors moderating the implementation of a medication review service. Relationships between implementation factors were complex, with most implementation factors

being interrelated. Motivation and individual identification with the organisation seemed critical factors in both hindering and facilitating the service implementation. Results from this study can inform the development of implementation programs and strategies to promote wider and faster implementation of professional services in pharmacy.

Declarations of interest

None.

Funding

The General Pharmaceutical Council of Spain funded, through a grant from Laboratorios Cinfa Limited the implementation study for medication review with follow-up service. The Council organised the participation of the local Colleges of Pharmacists. Laboratorios Cinfa Limited had no other role than providing funding. Neither of these organizations influenced the study design, analysis and interpretation of the data, writing of the manuscript nor the decision to submit this manuscript for publication.

List of abbreviations

BFI: Big Five Inventory

CFIR: Consolidated Framework for Implementation Research

FISpH: Framework for the Implementation of Services in Pharmacy

MRF: Medication Review with Follow-up

PCF: Practice Change Facilitator

SD: Standard Deviation

TICD: Tailored Implementation for Chronic Diseases.

Acknowledgements

This article is part of the Doctorate Thesis of Beatriz Pérez-Escamilla, within the Program of Clinical Medicine and Public Health, Granada University, Spain.

The authors would like to acknowledge the General Pharmaceutical Council of Spain who funded, through a grant from Laboratorios Cinfa Limited, the implementation study for medication review with follow-up service.

References

1. Balas EA. From appropriate care to evidence-based medicine. *Pediatric annals.* 1998;27:581-584.

2. Balas EA, Boren SA. Managing clinical knowledge for healthcare improvement. *Yearb Med Inform*. 2000;65-70.

3. Eccles MP, Mittman BS. Welcome to Implementation Science. *Implementation Science.* 2006;1.

4. Hateley-Browne J, Hodge L, Polimeni M, Mildon R. *Implementation in action. A guide to implementing evidence-informed programs and practices.* 1st ed. Australian Institute of Family Studies;2019.

5. Nilsen P. Making sense of implementation theories, models and frameworks. *Implement Sci.* 2015;10:53.

6. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, Lowery JC. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. *Implement Sci.* 2009;4:50.

7. Flottorp SA, Oxman AD, Krause J, et al. A checklist for identifying determinants of practice: a systematic review and synthesis of frameworks and taxonomies of factors that prevent or enable improvements in healthcare professional practice. *Implement Sci.* 2013;8:35.

8. Garcia-Cardenas V, Perez-Escamilla B, Fernandez-Llimos F, Benrimoj SI. The complexity of implementation factors in professional pharmacy services. *Res Social Adm Pharm.* 2017.

9. Bach-Mortensen AM, Lange BCL, Montgomery P. Barriers and facilitators to implementing evidence-based interventions among third sector organisations: a systematic review. *Implement Sci.* 2018;13:103.

10. Gastelurrutia MA, Benrimoj SI, Castrillon CC, de Amezua MJ, Fernandez-Llimos F, Faus MJ. Facilitators for practice change in Spanish community pharmacy. *Pharm World Sci.* 2009;31:32-39.

11. Langley AK, Nadeem E, Kataoka SH, Stein BD, Jaycox LH. Evidence-Based Mental Health Programs in Schools: Barriers and Facilitators of Successful Implementation. *School mental health.* 2010;2:105-113.

12. Nithianandan N, Gibson-Helm M, McBride J, et al. Factors affecting implementation of perinatal mental health screening in women of refugee background. *Implement Sci.* 2016;11:150.

13. Roberts AS, Benrimoj SI, Chen TF, Williams KA, Aslani P. Implementing cognitive services in community pharmacy: a review of facilitators used in practice change. *International Journal of Pharmacy Practice.* 2006;14:163-170.

14. Stokes T, Shaw EJ, Camosso-Stefinovic J, Imamura M, Kanguru L, Hussein J. Barriers and enablers to guideline implementation strategies to improve obstetric care practice in low- and

middle-income countries: a systematic review of qualitative evidence. *Implement Sci.* 2016;11:144.

15. Weir NM, Newham R, Dunlop E, Bennie M. Factors influencing national implementation of innovations within community pharmacy: a systematic review applying the Consolidated Framework for Implementation Research. *Implement Sci.* 2019;14:21.

16. Durlak JA, DuPre EP. Implementation matters: a review of research on the influence of implementation on program outcomes and the factors affecting implementation. *American journal of community psychology.* 2008;41:327-350.

17. Greenhalgh T, Robert G, Macfarlane F, Bate P, Kyriakidou O. Diffusion of innovations in service organizations: systematic review and recommendations. *The Milbank quarterly.* 2004;82:581-629.

18. Harvey J, Dopson S, McManus RJ, Powell J. Factors influencing the adoption of self-management solutions: an interpretive synthesis of the literature on stakeholder experiences. *Implement Sci.* 2015;10:159.

19. Lau R, Stevenson F, Ong BN, et al. Achieving change in primary care--causes of the evidence to practice gap: systematic reviews of reviews. *Implement Sci.* 2016;11:40.

20. Ahumada-Canale A, Quirland C, Martinez-Mardones FJ, Plaza-Plaza JC, Benrimoj S, Garcia-Cardenas V. Economic evaluations of pharmacist-led medication review in outpatients with hypertension, type 2 diabetes mellitus, and dyslipidaemia: a systematic review. *Eur J Health Econ.* 2019;20:1103-1116.

21. Garcia-Cardenas V, Armour C, Benrimoj SI, Martinez-Martinez F, Rotta I, Fernandez-Llimos F. Pharmacists' interventions on clinical asthma outcomes: a systematic review. *Eur Respir J.* 2016;47:1134-1143.

22. Jodar-Sanchez F, Malet-Larrea A, Martin JJ, et al. Cost-utility analysis of a medication review with follow-up service for older adults with polypharmacy in community pharmacies in Spain: the conSIGUE program. *PharmacoEconomics.* 2015;33:599-610.

23. Machado M, Bajcar J, Guzzo GC, Einarson TR. Sensitivity of patient outcomes to pharmacist interventions. Part II: Systematic review and meta-analysis in hypertension management. *Ann Pharmacother.* 2007;41:1770-1781.

24. Machado M, Bajcar J, Guzzo GC, Einarson TR. Sensitivity of patient outcomes to pharmacist interventions. Part I: systematic review and meta-analysis in diabetes management. *Ann Pharmacother.* 2007;41:1569-1582.

25. Malet-Larrea A, Garcia-Cardenas V, Saez-Benito L, Benrimoj SI, Calvo B, Goyenechea E. Cost-effectiveness of professional pharmacy services in community pharmacy: a systematic review. *Expert Rev Pharmacoecon Outcomes Res.* 2016;16:747-758.

26. Rotta I, Salgado TM, Silva ML, Correr CJ, Fernandez-Llimos F. Effectiveness of clinical pharmacy services: an overview of systematic reviews (2000-2010). *Int J Clin Pharm.* 2015;37:687-697.

27. Hossain LN, Fernandez-Llimos F, Luckett T, et al. Qualitative meta-synthesis of barriers and facilitators that influence the implementation of community pharmacy services: perspectives of patients, nurses and general medical practitioners. *BMJ open.* 2017;7:e015471.

28. Martínez-Martínez F, Faus-Dáder MJ, Fikri-Benbrahim N, García-Cárdenas V, Gastelurrutia MA, Malet-Larrea A, et al. conSIGUE. *Programa para la implantación y futura sostenibilidad del servicio de seguimiento farmacoterapéutico en la farmacia comunitaria española.* In: Portalfarma. 2016. https://www.portalfarma.com/Profesionales/InvestigacionFarmacia/conSIGUE/Documents/2017-Informe-Resultados-conSIGUE-Implantacion.pdf. Accessed 10.05.19.

29. Gastelurrutia MA, Faus MJ, Fernandez-Llimos F. Providing patient care in community pharmacies in Spain. *Ann Pharmacother.* 2005;39:2105-2110.

30. Ocampo CC, Garcia-Cardenas V, Martinez-Martinez F, Benrimoj SI, Amariles P, Gastelurrutia MA. Implementation of medication review with follow-up in a Spanish community pharmacy and its achieved outcomes. *Int J Clin Pharm.* 2015;37:931-940.

31. Pérez-Escamilla B G-CV, Gastelurrutia MA, Varas R, Sáez-Benito L, Martínez-Martínez F, et al. Perception of Practice Change Facilitators on the professional future of this new job in community pharmacy. *Pharm Care Esp*. 2014;16:81-8.

32. Moullin JC, Sabater-Hernandez D, Benrimoj SI. Qualitative study on the implementation of professional pharmacy services in Australian community pharmacies using framework analysis. *BMC Health Serv Res.* 2016;16:439.

33. Fixsen DL BK, Naoom SF, Wallace F. Core Implementation Components. *Res Soc Work Pract*. 2009;19(5):531-40.

34. Smith M, Ceni A, Milic-Frayling N, Shneiderman B, Mendes Rodrigues E, Leskovec J, Dunne C . (2010) *NodeXL: a free and open network overview, discovery and exploration add-in for Excel 2007/2010/2013/2016.* Social Media Research Foundation. https://www.smrfoundation.org. Accessed 12.30.19.

35. Borgatti SP EM, Johnson JC. Analyzing social networks. 2nd ed. Los Angeles: SAGE Publications; 2018.

36. Newman MEJ. *Networks: An introduction.* 1st ed: Oxford University Press; 2010.

37. Hansen DL, Shneiderman B, Smith MA. *Analyzing Social Media Networks with NodeXL. Insights from a Connected World*: Elsevier; 2011.

38. Brodka P, Musial K, Kazienko P. A Performance of Centrality Calculation in Social Networks. International Conference on Computational Aspects of Social Networks, France. *IEEE Computer Society Press.* 2009,24-31

39. Pinnock H BM, Carpenter C, Eldridge S, Grandes G, Griffiths CJ, Rycroft-Malone J, Meissner P, Murray E, Patel A, Sheikh A, Taylor SJC for the StaRI Group. Standards for Reporting Implementation Studies (StaRI) statement. *BMJ* 2017;356:i6795.

40. Glegg SMN, Jenkins E, Kothari A. How the study of networks informs knowledge translation and implementation: a scoping review. *Implement Sci.* 2019;14:34.

41. Yousefi-Nooraie R, Dobbins M, Brouwers M, Wakefield P. Information seeking for making evidence-informed decisions: a social network analysis on the staff of a public health department in Canada. *BMC Health Serv Res.* 2012;12:118.

42. Decuypere M. Visual network analysis: a qualitative method for researching sociomaterial practice. *Qualitative research.* 2019:1-18.

43. Garcia-Cardenas V, Benrimoj SI, Ocampo CC, Goyenechea E, Martinez-Martinez F, Gastelurrutia MA. Evaluation of the implementation process and outcomes of a professional pharmacy service in a community pharmacy setting. A case report. *Res Social Adm Pharm.* 2017;13:614-627.

44. Noain A, Garcia-Cardenas V, Gastelurrutia MA, et al. Cost analysis for the implementation of a medication review with follow-up service in Spain. *Int J Clin Pharm.* 2017;39:750-758.

45. Feletto E, Wilson LK, Roberts AS, Benrimoj SI. Measuring organizational flexibility in community pharmacy: Building the capacity to implement cognitive pharmaceutical services. *Res Social Adm Pharm.* 2011;7:27-38.

46. Rosenthal M, Tsao NW, Tsuyuki RT, Marra CA. Identifying relationships between the professional culture of pharmacy, pharmacists' personality traits, and the provision of advanced pharmacy services. *Res Social Adm Pharm.* 2016;12:56-67.

47. Nair D, Green JA, Marra CA. Pharmacists of the future: What determines graduates' desire to engage in patient-centred services? *Research in Social and Administrative Pharmacy.* 2020.

48. Shannon EA. Motivating the workforce: beyond the 'two-factor' model. *Aust Health Rev.* 2019;43:98-102.

49. Shoemaker SJ, Curran GM, Swan H, Teeter BS, Thomas J. Application of the Consolidated Framework for Implementation Research to community pharmacy: A framework for implementation research on pharmacy services. *Res Social Adm Pharm.* 2017;13:905-913.

50. Aarons GA, Ehrhart MG, Farahnak LR. The implementation leadership scale (ILS): development of a brief measure of unit level implementation leadership. *Implementation Science.* 2014;9:45.

51. Hattingh L, Sim TF, Sunderland B, Czarniak P. Successful implementation and provision of enhanced and extended pharmacy services. *Research in Social and Administrative Pharmacy.* 2020;16:464-474.

52. Fuller JM, Saini B, Bosnic-Anticevich S, Garcia Cardenas V, Benrimoj SI, Armour C. Testing evidence routine practice: Using an implementation framework to embed a clinically proven asthma service in Australian community pharmacy. *Res Social Adm Pharm.* 2017;13:989-996.

53. Harvey G, Loftus-Hills A, Rycroft-Malone J, et al. Getting evidence into practice: the role and function of facilitation. *J Adv Nurs.* 2002;37:577-588.

54. Kauth MR, Sullivan G, Blevins D, et al. Employing external facilitation to implement cognitive behavioral therapy in VA clinics: a pilot study. *Implement Sci.* 2010;5:75.

55. Crespo-Gonzalez C, Benrimoj SI, Scerri M, Garcia-Cardenas V. Sustainability of innovations in healthcare: A systematic review and conceptual framework for professional pharmacy services. *Res Social Adm Pharm.* 2020.

56. Chambers DA, Glasgow RE, Stange KC. The dynamic sustainability framework: addressing the paradox of sustainment amid ongoing change. *Implementation Science.* 2013;8:117.

57. Bopp M, Saunders RP, Lattimore D. The tug-of-war: fidelity versus adaptation throughout the health promotion program life cycle. *J Prim Prev.* 2013;34:193-207.

58. Carroll C, Patterson M, Wood S, Booth A, Rick J, Balain S. A conceptual framework for implementation fidelity. *Implementation Science.* 2007;2:40.

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