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Should the development of orthopaedic
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ABSTRACT

Background: Traumatic orthopaedic injuries are responsible for 5.8 million deaths every year, with 90% occurring in Low to Middle Income Countries. Approximately six times as many people are injured due to trauma than those who die of it. Nursing is an under-utilised resource in global trauma care and little research exists into the availability or training of skilled orthopaedic nurses in Low to Middle Income Countries.

Objectives: This scoping review aims to summarise and critique the existing body of research to identify if the development. And in some cases, establishment, of trauma and orthopaedic nursing should be a priority in low resource settings. The review also aims to identify any barriers to the advancement of the speciality, and any existing solutions to support nurses training and development.

Methodology: A scoping literature search was conducted, searching four databases (ProQuest, Medline, CINHALL and SOLAR) with key words and phrases to identify current literature.

Results: Eleven papers were identified. Key themes include the need to prioritise nursing education in Low to Middle Income Countries and upskill and utilise the nursing workforce to provide care to trauma patients.

Conclusions: Significant investment in the development of orthopaedic nursing is needed in Low to Middle Income Countries to reduce morbidity and mortality and retain the local nursing workforce.

Keywords: Education, Global Surgery, Nursing, Orthopaedic Trauma, Skill Set, Task-Shifting.,

1. BACKGROUND

Musculoskeletal disorders are the second largest cause of disability worldwide and the largest burden upon global surgical services (World Health Organisation [WHO] 2018a). 5.8 million people die from orthopaedic trauma and associated injuries every year and a further 50 million people suffer non-fatal injuries in Road Traffic Accidents' [RTAs], who require skilled surgical and nursing management (Lavy, Mkandawire and Muguti 2016). RTAs are the 8th leading cause of death globally, annually kill more people than malaria, Tuberculosis and Human Immunodeficiency Virus/Acquired Immunodeficiency syndrome combined, with 90% of those deaths occur in Low to Middle Income Countries [LMICs] (WHO 2015, Lavy et al. 2016). Injuries are associated with significant morbidity and mortality, and substantial economic burden for nations as approximately six times as many people are injured because of trauma as those who die from it (Lavy et al. 2013). LMICs are defined by the World Bank (2019) as those countries having a Gross National Income (GNI) of either \$1025 or less per capita in 2018 (low income) or a GNI per capita of \$1026 - \$3995 (lower middle-income). Examples of LMICs include Uganda, Botswana, and Sri Lanka (Organisation for Economic Co-Operation and Development [OECD] 2017).

Although a third of the global burden of disease is amenable to surgery, 67% of the worlds' population does not have access to safe, affordable and timely surgical care (Alkire et al. 2015, Crisp, Brownie and Refsum 2018). The United Nations [UN] Sustainable Development Goals (UN 2015) recognise the need to view access to safe surgery as a global health problem. Kotagal et al. (2014) suggests investing in surgical services could provide

significant economic benefits in resource-limited settings by reducing morbidity and mortality from traumatic injuries. Trauma and its associated impact upon a population's ability to work costs LMICS 3% of their annual Gross Domestic Product due to the disproportionate number of young men aged 15 – 29 affected (WHO 2016, WHO 2015). Nevertheless, progress towards meeting the UN's targets has been disappointing with few areas making any significant advancement (WHO 2018b).

My involvement in orthopaedic projects in Eastern Africa led to my interest in identifying the most sustainable ways to support the development of local nursing staffs' skill and competence in managing traumatic injuries. The Lancet Commission for Global Surgery (Meara et al. 2015) recognise the central role for skilled nursing care and recommend it as a priority to provide safe surgery. Nursing care of orthopaedic patients is increasingly recognised to be a highly specialised area of practice requiring specific skills from the nurses working within it (Clarke and Santy-Tomlinson 2014, Judd 2010, Santy et al. 2005, Clarke 2003). Regardless of this, the United Kingdom All-Party Parliamentary Group [APPG] on Global Health (2016) and the Nursing Now campaign (WHO 2018b) identify nursing as an 'invisible' quantity, under-recognised and under-valued even in High Income Countries [HIC]. As a result, a huge reservoir of skills, knowledge and talent is not being utilised. This is further compounded by a lack of research into the impact of nursing care, especially within LMICs (APPG 2016).

Nurses and midwives constitute almost 50% of the world's healthcare staff and are often the only source of healthcare for many people, but their skills are often not acknowledged and under-employed (Crisp et al. 2018, APPG 2016). WHO (2018a) identify the need to empower nurses to treat and manage traumatic injury, increasing healthcare capacity and improving patient outcomes. My experiences in an orthopaedic Regional Referral Unit in western Uganda highlighted the heavy burden of traumatic injuries in the

region, with local nurses identifying their desire for further training into the management of orthopaedic patients. Most research into orthopaedic trauma care in LMICs focuses upon provision of doctors or task-shifting (where professionals take on the roles traditionally fulfilled by fully qualified doctors) rather than the impact of skilled nursing care (Meara et al 2015). Access to safe and skilled nursing care is one resource for improving patient outcomes following traumatic injury, but nurses are often prevented from working to their potential due to erroneous perceptions about their skills and knowledge (APPG 2016). The objective of this review is to map the existing evidence regarding the potential need for development of trauma and orthopaedic nursing in LMICs', identify barriers to the advancement of the specialisation and potential sustainable solutions.

2. METHODOLOGY

This paper uses a scoping review methodology to map the available research for the development of orthopaedic trauma nursing in LMICs'. Scoping reviews are identified by Munn et al. (2018) and the Joanna Briggs Institute (JBI) (Peters et al. 2017) as a suitable methodology for reviews of emerging evidence, where precise questions are still unclear and so a systematic review is not appropriate. Unlike a systematic review, this approach allows a clear overview of the topic regardless of the quality of research, allowing a map of key concepts to be identified to provide direction for more defined future research (Archibald 2016). This methodology is applicable for this review which utilises a disparate range of research to develop a reflective overview of the topic, so identifying gaps in research and providing suggestions for future research.

This review has utilised the Peters et al. (2015) Framework for Scoping Reviews. The research question (see Table A), key search terms (Table B), and inclusion/exclusion criteria (Table C) were formulated using the Population/Concept/Context (PCC) mnemonic. To ensure a broad range of evidence is included, the inclusion criteria does not restrict study design. LMICs are defined using the World Bank (2019) and OECD (2017) classifications. As orthopaedic nursing is not recognised as a distinct speciality in many LMICs, studies have been included which look at general surgical nursing which includes orthopaedic care. Studies only looking at alternative surgical specialities (for example gynaecology) have been excluded. Much of the existing research focuses upon either doctors or surgical teams as a whole. Therefore, studies looking only at doctors have been excluded, but studies incorporating multidisciplinary teams containing nurses are included. Papers which look at international collaborations to support education for local staff have been included, but those international collaborations with no education for local staff have been excluded. Truncation was used to consider varied global spellings of works such as orthopaedics (see Table B). The Boolean operators AND and OR were used to combine search terms.

CINAHL, MEDLINE, ProQuest and SOLAR databases were searched due to their nursing and healthcare focus.

INSERT TABLES A and B HERE

Appendix 1 highlights how papers were identified during this search. Due to the mixed methodologies included in this study, papers were appraised using the Caldwell Appraisal tool (Caldwell et al. 2005).

3. FINDINGS

Appendix 2 gives a brief overview of the papers found in this search which met the search criteria. The quality of these papers is discussed, but not rated in accordance with scoping review methodology (Peters et al. 2017).

11 papers were identified in this study. 4 papers conducted primary quantitative research (Chu et al. 2011, El-Dakhakhny 2010, Nogaro et al. 2015, Petroze et al. 2015), 1 conducted primary mixed-methods research (Nwanna-Nzewunwa et al. 2016), 1 paper was a reflective review with some quantitative data provided (Wellington 2013), 3 conducted primary qualitative research (Wesson et al. 2013, Wesson et al. 2015, Timmins et al. 2018), 1 paper described an intervention (Han et al. 2017) and 1 paper was a descriptive review paper (Carter and Snell 2016).

Few empirical research papers looked explicitly at orthopaedic nursing in LMICs. Only three papers looked specifically at nursing care in surgical settings (Carter and Snell 2016, Timmins et al. 2018, El-Dakhakhny 2010) and two papers exclusively discuss orthopaedic nursing skills in LMICs (Han et al. 2017, Wellington 2013). Separately only two papers conducted primary research (Timmins et al. 2018, El-Dakhakhny 2010). Most papers looked more widely at orthopaedics and surgical care, largely focussing upon the medical speciality with some mention of nursing care (Chu, Ford and Trelles 2011, Nwanna-Nzewunwa et al. 2016, Wesson et al. 2015, Wesson et al. 2013, Petroze et al. 2013).

Wellington (2013), Han et al. (2017) and Carter and Snell's (2016) papers were all largely descriptions of the authors experiences with no identification of sample sizes, data collection or data analysis. Wellington (2013) did present some data about nurses' perceptions of their knowledge post-education, but no information was offered on the methodology behind this. Therefore, the results are challenging to satisfactorily analyse for

quality or rigour, although the author identifies the paper as a reflective piece as opposed to empirical research. Although these papers may be rated as low-quality utilising systematic review methodology, scoping reviews allow a broader range of evidence type and quality to be included (Peters et al. 2017). This is appropriate here as they give valuable insight into the nursing experience within some LMICs where nursing -specific empirical research is scarce.

Statistical analysis was undertaken by Chu et al. (2011), El-Dakhakhny (2010), Nogaro et al. (2015) and Petroze et al. (2015), all of whom found statistically significant findings, adding credibility and reliability to their findings and recommendations. Descriptive statistics and thematic analysis were also used by Nwanna-Nzewunwa et al. (2016). Their utilisation of mixed-methods methodology, and size and breadth of the study, afforded a richness to their data and allowed a wider perspective to be gained of surgical care in Uganda. In comparison, Wesson et al. (2013, 2015) identified themes through theoretical analysis adding a level of detail found in qualitative research, though this limits generalisability. However, El-Dakhakhny (2010), Petroze et al. (2015), Wesson et al. (2013) and Timmins et al. (2018) had small sample sizes in comparison with larger scale studies by Chu et al. (2011), Nogaro et al. (2015) Nwanna-Nzewunwa et al. (2016), Wesson et al. (2015), making their results potentially less generalisable to the global health community.

Several themes were identified throughout the literature. These themes have been presented in two categories: Barriers to orthopaedic Nursing in LMICs and Possible Solutions. Sub-themes are identified and discussed within each category.

4. DISCUSSION

4.1 Barriers to orthopaedic nursing in LMICs

4.1.1 Perceptions of Nursing

APPG (2016) identify perception as a core barrier to the empowerment and utilisation of the nursing workforce, with nurses not supported to work to their potential or unable to access opportunities to develop leadership skills. A hierarchy imbalance has been found in some LMIC's where nurses are viewed as doctors 'handmaidens' and 'follow' medical staffs' instructions rather than be trained in independent evidence-based practice – resulting in a lack of nurse-led decision making and a lack of nursing empowerment (Stringer et al. 2014, Timmins et al. 2018). Wellington (2013) found the patriarchal structure of healthcare in Malawi meant nurses were not rewarded or encouraged to engage in ongoing personal development, and so were not motivated to do so.

Surgical care in LMICs is associated with related complications, such as poor fluid monitoring due to a lack of knowledge and resources (Carter and Snell 2016, Timmins et al. 2018). Nurses caring for trauma patients need to understand and identify physiological implications of injury to prevent patient deterioration. However even a basic skill set of accurately recording physiological observations is not always recognised as being within the scope of nursing practice in LMICs. Basic nursing care, such as pressure sore care, is often undertaken utilising outdated methods no longer supported by a current evidence base (Wellington 2013). Crisp et al. (2018) highlight this waste of skills as a barrier to achieving Universal healthcare.

WHO (2018a) and the World Innovation Summit for Health [WISH] (Crisp et al. 2018) emphasise the need to recognise nurses' role at the centre of healthcare, empower them to improve outcomes for patients and ensure they are appropriately trained to do so.

However little primary research looks explicitly at nurse training and competence within the global surgical community (AAPG 2016), despite recognition that higher levels of nurse education and training lead to improved patient outcomes (International Council of Nurses [ICN] 2004). Empowering nurses to practice to their full sphere of competence may lessen the economic burden of traumatic injuries. The global Nursing Now campaign attempts to address the ‘invisibility’ of the profession, although this is a complex undertaking (Crisp et al. 2018, WHO 2018b). Meara et al. (2015) call for significant investment, political motivation and action to address concerns regarding surgical infrastructure in LMIC’s. APPG (2016) especially highlight the failure to recognise the potentially positive impact of skilled nursing care in reducing mortality and morbidity.

4.1.2 Resources

The perception of surgery as a ‘luxury’ commodity that LMICs cannot afford is shifting with the realisation that it is a cost-effective way of managing disease burden and allowing countries to achieve economic growth (Bickler and Speigel 2010, UN 2015). Meara et al. (2015) predict that without significant up-scaling of surgical services in LMICs there will be economic losses of US\$ 12-13 trillion in LMICs due to loss of productivity. Patients in LMICs are often cared for on mixed-speciality wards with poor staffing ratios, with friends and families taking of the ‘nursing’ role (Chagomerana et al. 2017, Nwanna-Nzewunwa et al. 2016, Carter and Snell 2016). My own experience in Western Uganda saw patients with open fractures being cared for on mattresses on the floor next to burns, general surgery and maternity patients. Patients often wait weeks for surgery until they can afford orthopaedic prosthesis, or a specialised surgeon becomes available. There are, for example, 21684 qualified surgeons within the United Kingdom compared to 42 in Rwanda, 23 in Liberia, 115

in Haiti and 15 in Somalia (WHO 2018c). Delays are not unusual and the health and economic implications for patient outcomes can be significant (Nwanna-Nzewunwa et al. 2016, Timmins et al. 2018). The risk of surgical site infection in trauma patients increases when basic hygiene is not maintained. For example, appropriately nursing patients by segregating ‘dirty’ wounds from ‘clean’ orthopaedic wounds is a simple but effective intervention (Bardossy et al. 2016). Khotagal et al. (2014) found hospital investment in surgical capacity for traumatic injuries, even in resource-limited settings, to be amongst the most cost-effective of all health care interventions. Nurses are central to this care, and if supported to develop nursing decision making skills, will be more effective still.

4.1.3 Staff Retention

There is a predicted global deficit of 12.9 million skilled healthcare workers by 2035 (WHO/GWA 2014). The staffing crisis is most acute in LMICs where nurse to patient ratios are well below the WHO recommended numbers. Retention and recruitment of staff is undermined by significant stress due to high patient numbers, scarce resources, and poor pay and status for nursing staff (Petroze et al. 2014, Carter and Snell 2016). The demand of traumatic injuries remains high. Studies in Uganda, Malawi and Somalia have shown as many as 50% of injuries in the county are caused by RTAs, and 15% of the associated hospital admissions being due to long bone fractures (O’Hara et al 2014, Chagomerana et al. 2017, Chu et al. 2011). WHO (2018a) emphasise the need to engage nurses to better manage this growing surgical disease burden and ensure there is healthcare coverage across rural and urban areas, but there are substantial barriers to the recruitment and retention of qualified staff.

The staffing crisis is compounded by workload. Aitken et al. (2014) link an increase of even one patient per nurse to a 7% increase in patient mortality. In Zambia patient to nurse ratios are as low as 60:1, whilst in Malawi wards supporting a singular orthopaedic theatre at times had staffing ratios of either 40:1 or 80:1 (Carter and Snell 2016, Chagoerana et al. 2017, Qureshi et al. 2012). Anderson et al. (2017) report that on top of significant clinical workload, nurses in southern Uganda are also expected to do everything from maintain patient records, to cleaning stockrooms. Accurate record keeping is therefore challenging and staff are at high risk of fatigue and burnout, whilst overall quality of care is reduced (Meara et al. 2015).

Rural areas are often most affected, with specialist orthopaedic services centralised into major urban areas (Chawla et al. 2016). Staff in rural areas may be attracted by better pay and career satisfaction elsewhere, leading to skilled staff leaving for superior opportunities in urban areas or abroad (Ma et al. 2012, Stringer et al. 2014). The exodus of staff leaving rural areas compounds the already significant gaps in the local workforce (McKimm et al. 2013, Han et al. 2017). As such, it is not enough only to consider the number of staffs, but also how to incentivise them to stay so LMICs retain their skills and experience (Qureshi et al. 2013). Furthermore, it is not just insufficient numbers of nurses which is problematic, but also that the existing nurses are not always sufficiently educated (Ma et al. 2012). The quality, standards and performance of those staff must also be a factor as the management of traumatic injuries requires significant skill (Allen and McKimm 2013).

4.2. Possible Solutions

4.2.1 Improving and Developing Nurse Education in LMICs'

The level of nursing education has a directly proportional relationship with the quality of care, with higher levels of education recognised to increase nurses' knowledge and skill set (Ma et al. 2011, Wesson et al. 2013, Han et al. 2017, Wellington 2013). Arguably nurses in LMICs needed to be more highly trained than colleagues in HICs due to the complexity of injuries they treat with limited resources and clinical support, requiring both generalist and specialised skills (APPG 2016).

Training nurses to use principles of health promotion to recognise and prevent complications from trauma is a cost-effective intervention to reduce morbidity and mortality from injuries (Han et al. 2017, Wesson et al. 2013, Ma et al. 2012, Wellington 2013). Despite this Timmins et al. (2018) and APPG (2016) state that this aspect of nursing care is often poorly recognised and inadequately exploited. In many LMICs where appropriate infrastructure and facilities to support surgical care are lacking, the need for competence from existing nursing staff is even more vital (Carter and Snell 2016, Bickler and Spiegel 2010). This is highlighted by Nwanna-Nzewuwa et al. (2016) and Chagomerana et al. (2017) who link increased mortality to prolonged periods in skeletal traction for patients with long bone fractures. They did not look particularly at the nursing management of traction but, El-Dakhakhy (2010) found significant improvement in traction care after introducing educational interventions, with nurse knowledge of managing complications improving post-test by 96.7%.

Tailored orthopaedic training for general nurses is advocated in the literature (Nwanna-Nzewunwa et al. 2016, Han et al. 2016, El-Dakhakhy 2010, Wellington 2013, Meara et al. 2015, APPG 2016, WHO 2015). However it remains challenging to assess successful training programmes long term due to difficulties collecting post-intervention data (Petroze et al. 2014). Simple low-cost interventions, such as early mobilisation post-surgery, can be effective if delivered in a sustainable way (Stringer et al. 2014). Khon Khaen in

Thailand reduced morbidity and mortality from traumatic injuries reduced by almost 50% after introducing a Trauma Review Board and subsequently targeting training (WHO 2015). Han et al. (2017) further addresses the cost-efficacy of sufficiently training nurses to care for complex patients although Petroze et al. (2014) point out significant change is likely to be multi-factorial and education cannot overcome all external factors.

The challenges are highlighted by Chockotho et al. (2016) who found only 72% of hospitals in parts of East, Southern and Central Africa can offer any type of closed fracture management and only 4% of district hospitals have a sustainable supply of orthopaedic implants. Ensuring nurses have access to ongoing education will likely improve staff retention, as well as nurses' clinical skills and decision making. As has been somewhat successful with Clinical Officers's [CO's], provision of specialised training to staff may entice nurses to stay by offering career-enhancing opportunities (Qureshi et al. 2013, Ma et al. 2012). Poor availability of further training for nurses cannot be remedied without economic investment and proactive support at local and national governmental levels, but this lack of investment prevents healthcare systems from utilising the available resources (WHO 2018, ICN 2009, APPG 2016).

4.2.2 Task Shifting and Leadership

The existing infrastructure within many LMIC hospitals does not always support timely trauma care. In Kenya many regional hospitals do not have recognised emergency departments and triage is undertaken in outpatient departments. Similarly, there is no intensive care support after surgery, with patients requiring this transferred out to national

centres, if resources exist to facilitate this (Wesson et al. 2013). Encouraging nurses to undertake independent clinical decision making and task-shifting could have a significant impact upon patient outcomes, whilst also improving career satisfaction and in turn retention (Stringer et al. 2014, Chu et al. 2011). Allen and McKimm (2013) discussed the idea of increasing the scope of nursing practice to bridge the gap between decreasing medical staffing resources, an idea successfully and safely implemented in many LMICs where COs and nurse anaesthetists are an established alternative to fully trained doctors (Nwanna-Nzewunwa et al. 2015, Chu et al. 2011, Qureshi et al. 2013).

These roles could utilise nurses more efficiently when medical staff are scarce, as studies in Myanmar have shown (Han et al. 2017). In Somalia, nurses in remote areas carry out emergency surgery and provide anaesthesia after informal “on the job” training from an experienced qualified doctor, successfully addressing an urgent need for emergency surgical care with resultant low peri-operative mortality rates (Chu et al. 2011). Paradoxically whilst task-shifting should be a complement, not replacement, to fully-trained doctors, the lack of medical staff has itself created the need for task-shifting (Meara et al. 2015, APPG 2016). Increasing the numbers of trained doctors comes with its own challenges and much global health research focuses upon how to address this and overcome barriers to training, and retaining, adequate numbers of qualified doctors in LMICs (Nwanna-Nzewunwa et al. 2016, Petroze et al. 2014, Wesson et al. 2013, Chu et al. 2011, Qureshi et al. 2012, Anderson et al. 2017, Akenroye et al. 2013).

To safely task-shift, training and mentorship is needed to allow adequate skill development though this is under threat even in HICs where nurse’s post-graduate training has been eroded (ICN 2009). In some areas this is leading to active de-skilling, and so under-utilisation, of the nursing workforce. In Haiti, Timmins et al. (2018) found doctors undertaking surgical wound dressings, so nurses perceived it to be the doctors’ role to do so

and mis-trust between the professions became evident. Crisp et al. (2018) found nursing is simply not valued in some places, and so whilst task shifting can be an efficient and effective use of resources, supporting systems are not always in place.

Stringer et al. (2016) demonstrate the importance of effective inter-disciplinary relationships and communication in Botswana, and the role improved nursing leadership and education can play in improving respect and communication between professional disciplines. Replicating this respect elsewhere may require significant cultural change underpinned by political and managerial support, though some international partnerships are in place to provide mentorship and training (Stringer et al. 2014, Carter and Snell 2016, Han et al. 2017, Wellington 2013). Arguably whilst extended roles for nurses may solve some issues regarding lack of doctors, skilled nursing care is still needed and extending the scope of nurses may reduce the personnel available to provide this (APPG 2016). As nurses are often the only healthcare professional some people will ever meet, developing nursing skills to manage injuries and illnesses within their own sphere of competence could be most effective (Crisp et al. 2018).

4.2.3 International Collaborations

Petroze et al. (2015), Nogaro et al. (2015), Chu et al. (2011), Wellington (2013), and Han et al. (2017) highlighted the potential impact of international collaborations upon the improving knowledge and skill set of local staff. These partnerships are typically healthcare staff from HIC's sharing knowledge, practice and training with colleagues in LMICs. These collaborations are not uncommon within the medical field. Nogaro' et al's (2015), Petroze et al. (2015) and Chu et al. (2011) all provided surgical training to a range of healthcare

professions. These types of initiative can be highly effective at providing support and training tailored to the needs of the local healthcare staff.

There are comparatively fewer projects targeting general orthopaedic nursing development, but those that exist replicate the medical projects success in improving skills, confidence and competency (Wellington 2013, Han et al. 2016), though neither of these studies provided statistical analysis to test the significant of the findings. The success of such collaborations is further supported by a Botswanan-American partnership to develop nursing scholarship (Stringer et al. 2016). Though not a surgical project, Botswanan nurses' confidence in utilising evidence-based practice was improved through an international mentorship and training system which allowed them to develop nursing leadership and clinical decision making.

Nonetheless international collaborations alone do not conclusively address the need for LMICs to develop an infrastructure which enables them to cultivate a flexible nursing workforce, appropriately trained and able to meet the needs and realities of their local communities (Qureshi et al. 2012, Chu et al. 2011, Nwanna-Nzewunwa et al. 2016). For international collaborations to be effective, identifying specific needs and developing strong relationships are vital to overcome inevitable cultural, economic and political barriers to change. For example, friction and uncertainty can occur when solutions for safe surgery which are life-saving in LMICs may be incorrectly perceived as unsafe by those used to working in HICs. O'Hara (2015) explores this further, stressing that whilst international collaborations can be effective, surgical practises from HICs are often not suitable or economically realistic in LMICs. Furthermore, economic instability can undermine international efforts, and then hamper sustainability and impact of these partnerships (Qureshi et al. 2013). Collaborations can be further complicated when there is a threat to international

staff. Further challenges of developing sustainable partnerships exist in areas of conflict, where expatriate staff can be especially vulnerable to external risks such as kidnapping (Chu et al. 2011). The real long-term impact of these alliances is challenging to accurately assess against the backdrop of incredibly complex environments where effective and reliable systems to collect and analyse data are not always in place (Han et al. 2016, Petroze et al. 2014).

5. CONCLUSIONS

The evidence in this scoping review suggests there is a need to develop orthopaedic nursing skills in LMICs to reduce patient mortality and morbidity, but barriers to doing so are complex and cannot be overstated or easily remedied. Despite a wealth of research recognising the burden of injuries, and the need to build surgical capacity, a considerable gap exists looking specifically at the role of nurses within this. Whilst there is great potential to improve patient outcomes by better utilisation and education of the nursing workforce, substantial research is needed to look specifically at orthopaedic nursing care in LMICs. The lack of visibility for the profession makes it challenging to fully highlight the potential benefits of utilising nursing efficiently. Despite this, the limited existing research directly links skilled nursing care to improved patient outcomes, and this could be even more significant in LMICs where the burden of disease is high, and available resources are scarce. The Nursing Now campaign highlights the importance of sufficiently recognising, engaging and training nurses to meet the Sustainable Development Goals and reduce morbidity and mortality from Non-Communicable Diseases. Investing in the global nursing workforce may

also lead to empowerment and improved staff retention in areas where this is most needed. Significant and targeted primary research is needed into this area to identify ways to address the barriers currently facing nurses working in these areas and allow capacity building within global trauma care.

Recommendations for Future Research

- Nurse-led research from nurses based in LMICs to increase the understanding of the training needs of local staff.
- Primary longitudinal research into nurse-led training for orthopaedic nurses in LMICs to evaluate the impact of training initiatives.

Limitations

This study has been conducted by a single author, and so the data has been analysed by one individual from a high-income country who has spent time working clinically in Eastern Africa. This topic would benefit from wider exploration by a collaboration of authors from a variety of LMICs and HICs to include a broader perspective of the subject.

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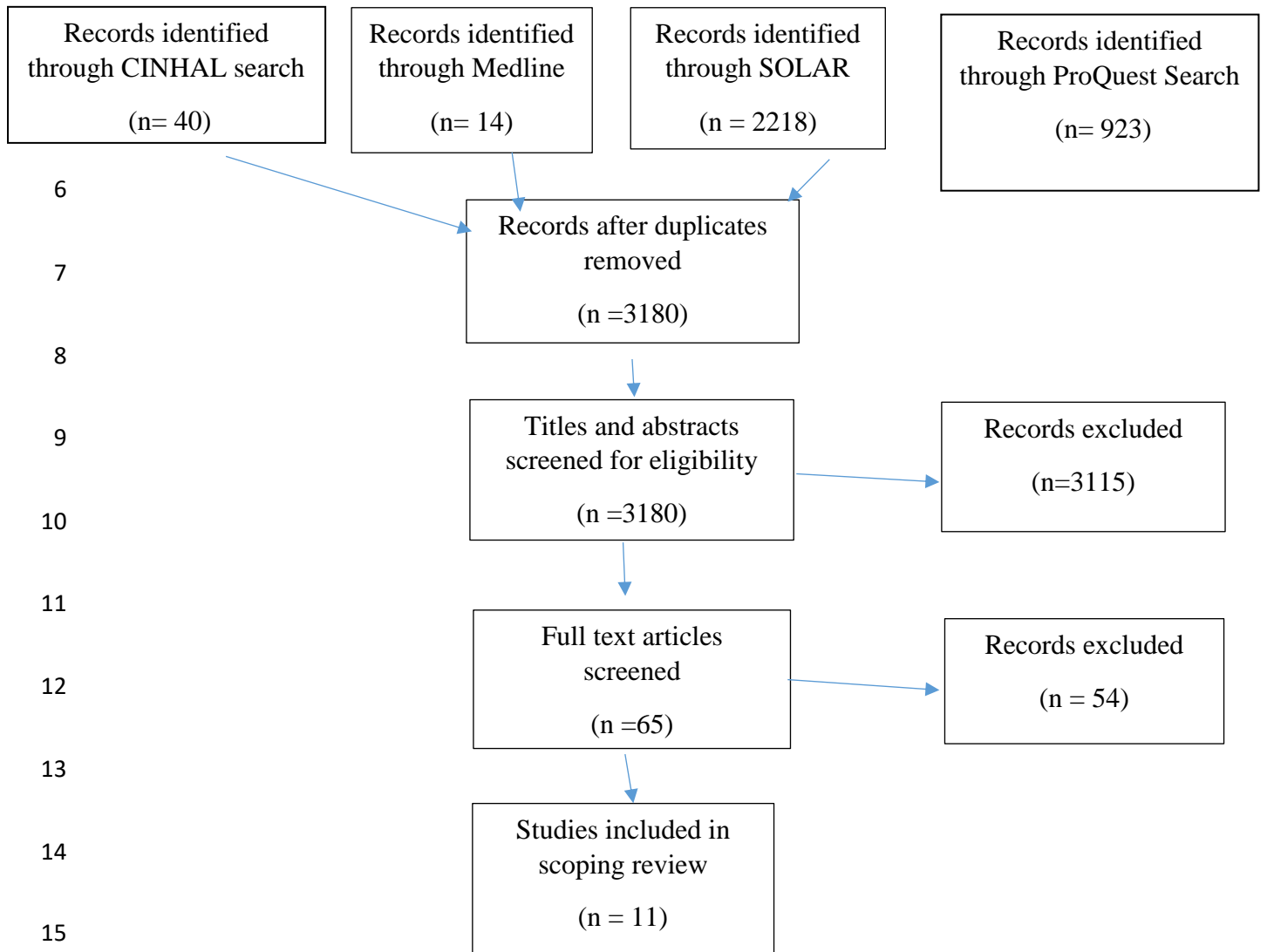
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Appendix

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2.3 Table C – Evidence identification flow chart.



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2.4 Table D – Evidence Table

Authors, date and geographical location	Aims	Methodology	Sample	Findings
Carter and Snell (2016) Zambia	To provide an overview of nursing critically ill surgical patients in LMIC.	Review paper	n/a	Little funding is directed towards critical care and ward nursing programmes in LMIC and without investment into nursing, funding going towards surgical and anaesthetic services may not reach their full potential
Chu, et al. (2011)	A statistical review and comparison of	Quantitative data analysis,	Data collection from October 2006 –	Trauma accounted for 76% of 1602 patients. Operative

Somalia	the surgical mortality rates of qualified Medicins Sans Frontier staff and local Somalian staff trained to task-shift.	post-intervention.	December 2009. 2086 operations in total. Data collected from all surgeries involving anaesthesia.	mortality no different between visiting medical teams and local Somalian teams conducting surgery (1.7% (6 cases) of surgeries conducted by surgeons and 0.2% (2 cases) of surgeries conducted by no-surgeons).
El-Dakhakhny (2010) Egypt	To improve paediatric nurses' understand of how to implement and care for children with fractured limbs in	Quasi-experimental. Data collected Pre- and Post-educational training programme.	N = 30 nurses working in an orthopaedic surgical department. All children from 3 months to 10 years being treated	93.3% of nurses had had no prior training on Thomas traction. Low pre-intervention knowledge of complications of traction. Knowledge significantly

	traction Thomas		with Thomas traction.	improved post- education.
Han et al. (2017)	Description of a collaboration between Australian and Republic of the Union of Myanmar orthopaedic nurses	Qualitative descriptive paper	Senior orthopaedic nursing staff from Myanmar – numbers not identified	The collaboration is creating a supportive environment for Myanmar nurses to develop their skills and encourage multi-disciplinary working and respect.
Nogaro et al. (2015) Central and Eastern Africa	To see if delivering formal primary trauma care courses in seven East and Central African countries can improve clinical staffs' knowledge	Quantitative pre and post intervention	240 doctors 99 non-medical staff (nurses, student nurses, clinical officers and plastering technicians)	Courses improved knowledge and confidence (91% improvement overall). The non-doctors showed statistically significant improvement (20% vs 16% p<0.05).

	and confidence managing trauma.			
Nwanna- Nzewunwa et al. (2016) Uganda	To identify barriers and facilitators to timely surgical care in Ugandan Regional referral Unit	Mixed Methods including retrospective medical record review, focus groups, observation.	Regional Hospital Inpatient records from May 2015-June 2015 for all non-obstetric surgical emergencies. Focus groups of nurses, doctors and administrative staff	Procedures performed by Consultant surgeons (21%), orthopaedic officers (11%) and nurses (4%). 48.4% of patient experienced delays in treatment (median delay time 14.8 hours). Limb fractures treated by traction, no open repair facilities available. Barriers in staffing, skills and infrastructure.
Petroze et al. (2015)	To identify if a focused trauma	Quantitative post- and post-	24 faculty surgeons and	Mortality of severely injured patients decreased

Rwanda	education initiative could improve injury-related outcomes and resource utilisation.	intervention audit	15 trauma nurses	after focused trauma education (8.8 to 6.3% p = 0.09), but no improvement in resource utilisation was found.
Timmins et al. (2018) Haiti	To describe barriers and facilitators to nurses providing quality wound care in three surgical wards, including orthopaedics.	Qualitative descriptive: interviews and observational data	15 wound care observations 13 nurse interviews and 3 medical resident interviews	Nursing wound care may be improved by improving the professional status and working conditions of nurses
Wellington 2013	A reflection upon success of a collaboration between Scottish and Malawian	Qualitative reflection- some post-intervention data reported	Not specified	Malawian nursing staff found the collaboration and training positive. Improved post-intervention knowledge

	Orthopaedic nurses			(statistics not reported)
Wesson et al. (2015) Kenya	To present perceptions of systems used to triage and transport patients and explore triage capabilities in district hospitals.	Qualitative focus groups and key informant interviews.	Focus groups (n = 102) recruited from local community centres. Key informant interviews (n=24) participants specifically recruited by research staff.	Very limited pre-hospital care availability and advanced trauma care rarely available in hospitals. Recommendations for a team approach to improve patient outcomes.
Wesson et al. (2013) Kenya	To describe trauma care capacity in two Kenyan hospitals and identify ways which it can	Qualitative Interviews and 4 – point questionnaires	17 hospital staff, including clinical and administrative staff.	Strengthening trauma care has the potential to strengthen. Although the implementation is challenging and faces barriers, both

	be strengthened.			hospitals display strong commitment to doing so.
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Tables

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4 2.1 Table A - Keywords

Population	Concept	Concept	Context
Nurs*	Orthop*edic	Knowledge	Global Surgery
Healthcare Professional	Musculoskeletal	Skills	Low to middle income countries [LMICs]
	Trauma	Training	Developing Countries
	Injury	Education	Low resource country

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7 2.2 Table B – Inclusion/Exclusion Criteria

Inclusion	Exclusion
Research conducted in Low to middle income countries	Research conducted in High income countries
Orthopaedic Trauma	Other types of trauma (e.g. neurosurgery, general surgery)
	Elective orthopaedic surgery

Nursing care (including papers looking at the multidisciplinary team where nurses are a member)	Focus upon medicine only
Published >2008	Published <2008
Peer reviewed articles only	Non-Peer reviewed articles
Papers written in English	Papers not written in English
Focus upon education/skills/knowledge	Papers focussed upon specific medication delivery (e.g. Tranexamic acid)
Focus upon visiting surgical teams from HIC who utilise educational interventions for local staff	Papers focussed upon surgical team visits from HIC with no educational interventions for local staff

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