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## ■ TRAUMA

# Standardization of global hip fracture audit could facilitate learning, improve quality, and guide evidence-based practice

AN INTERNATIONAL STUDY OF HIP FRACTURE REGISTRIES IN 20 COUNTRIES USING THE FRAGILITY FRACTURE NETWORK 2022 MINIMUM COMMON DATASET

### Aims

National hip fracture registries audit similar aspects of care but there is variation in the actual data collected; these differences restrict international comparison, benchmarking, and research. The Fragility Fracture Network (FFN) published a revised minimum common dataset (MCD) in 2022 to improve consistency and interoperability. Our aim was to assess compatibility of existing registries with the MCD.

### Methods

We compared 17 hip fracture registries covering 20 countries (Argentina; Australia and New Zealand; China; Denmark; England, Wales, and Northern Ireland; Germany; Holland; Ireland; Japan; Mexico; Norway; Pakistan; the Philippines; Scotland; South Korea; Spain; and Sweden), setting each of these against the 20 core and 12 optional fields of the MCD.

### Results

The highest MCD adherence was demonstrated by the most recently established registries. The first-generation registries in Scandinavia collect data for 60% of MCD fields, second-generation registries (UK, other European, and Australia and New Zealand) collect for 75%, and third-generation registries collect data for 85% of MCD fields. Five of the 20 core fields were collected by all 17 registries (age; sex; surgery date/time of operation; surgery type; and death during acute admission). Two fields were collected by most (16/17; 94%) registries (date/time of presentation and American Society of Anesthesiologists grade), and five more by the majority (15/17; 88%) registries (type, side, and pathological nature of fracture; anaesthetic modality; and discharge destination). Three core fields were each collected by only 11/17 (65%) registries: prefracture mobility/activities of daily living; cognition on admission; and bone protection medication prescription.

### Conclusion

There is moderate but improving compatibility between existing registries and the FFN MCD, and its introduction in 2022 was associated with an improved level of adherence among the most recently established programmes. Greater interoperability could be facilitated by improving consistency of data collection relating to prefracture function, cognition, bone protection, and follow-up duration, and this could improve international collaborative benchmarking, research, and quality improvement.

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### Introduction

National hip fracture registries have been shown to be effective drivers for quality improvement and the design of specialist multidisciplinary

services.<sup>1-3</sup> They facilitate the delivery of holistic, evidence-based care in accordance with standardized national guidelines, and are associated with better patient outcomes including shorter hospital

admissions, lower post-discharge care needs, and reduced mortality.<sup>4,6</sup> This practice has expanded since the establishment of the original Rikshöft programme in Sweden, and the publication of the Standardized Audit of Hip Fracture in Europe (SAHFE), and there are now 17 recognized national registries operating in 20 different countries.<sup>7-10</sup>

The Fragility Fracture Network (FFN) is a global multidisciplinary network that was established to improve the management and secondary prevention of fragility fractures, and is ideally placed to promote multidisciplinary collaboration in monitoring and improving the care provided to people with a hip fracture.<sup>11</sup> In 2014, the FFN defined a minimum common dataset (MCD) that set out the basic structure of data collection that would be necessary if a national registry wished to audit and improve hip fracture care on a national level.<sup>12</sup> This was revised and streamlined by the FFN Hip Fracture Audit (HFA) Special Interest Group (SIG) in 2022 based on contemporary evidence, in addition to pooled experience from administrators of ten established registries, with the aim of improving compatibility between existing registries and encouraging the establishment of new programmes in other countries.<sup>13</sup>

The 2022 MCD sought to provide a framework for international benchmarking of care quality and outcomes through direct comparison of equivalent data from different countries. This could then provide evidence and incentive for clinicians to advocate for resource allocation and facilitate shared learning across common themes in hip fracture care.<sup>7,14</sup> Furthermore, the MCD aimed to increase compatibility across datasets. This would provide opportunities for greater collaborative research through the compilation of larger and more diverse data, allow the introduction of experimental studies across different healthcare settings, and permit responsiveness to supraregional challenges in hip fracture care.<sup>15,16</sup>

The primary aim of this study was to assess the compatibility of the existing 17 national hip fracture audit programmes with the new FFN 2022 Minimum Common Dataset. The secondary aim was to highlight specific areas where interoperability could be improved.

## Methods

**Study design.** This study was carried out by the authors on behalf of the FFN Hip Fracture Audit Special Interest Group, which is composed of nominated representatives from each of the established national hip fracture programmes, continental FFN representatives, and senior figures from the FFN administration.<sup>17</sup> The study assessed compatibility of the included hip fracture programmes by auditing adherence of each to the FFN 2022 MCD.<sup>15</sup>

A total of 17 hip fracture registries covering 20 countries were evaluated. These were considered in three discrete groups based on origin and duration since becoming established: 1) first-generation registries (the longest established programmes that originated from Scandinavia, including: Denmark; Norway; and Sweden); 2) second-generation registries (whose structure was based on the first-generation experience, including: Australia and New Zealand; England, Wales, and Northern Ireland; Germany; Ireland; Netherlands; Scotland; and Spain), and 3) third-generation registries (that have been recently established,

are in an introductory period, or have not yet reached nationwide coverage, including: Argentina; China; Japan; Mexico; Pakistan; the Philippines; and South Korea).<sup>9,18-28</sup>

**Benchmark dataset.** The FFN 2022 MCD includes unit and patient identifiers and 20 core fields that are used to capture demographic details, injury and clinical assessment data, surgical and inpatient management factors, and outcome measures (Supplementary Figure a). An additional 12 optional fields allow audits to adapt data collection to meet the specific needs of the health service. These optional fields include data relating to timing of injury and interventions, broader clinical management variables, and more granular post-discharge outcome measures collected at defined audit follow-up timepoints (Supplementary Figure b).

**Data collection.** Each national programme data template was reviewed and the compatibility (considering variable type and format) was determined. Where necessary, clarification and verification was sought from audit coordinators from each nation to ensure validity of the findings, as well as to identify: barriers to increasing adherence; specific fields where compatibility could be improved; and the suitability of the recommended MCD data fields for comparison of performance across hospital, regional, and national levels relevant to their own healthcare system.

**Statistical analysis.** The results are presented using absolute numbers and percentages. No inference statistics were applied.

## Results

There were 17 included registries covering 20 nations. The mean age since inception of the first-, second, and third-generation registries was 24 years (17 to 34), nine years (6 to 15), and two years (0 to 6), respectively. The oldest registry was from Sweden (34 years) and four of the most recent registries (Argentina, China, Mexico, and Pakistan) had been established for one year or less.

**Established versus developing programmes.** The mean compatibility with the MCD fields (combined core and optional elements) among the established registries was 70% (59 to 91). The first-generation registries were collecting 60% (53 to 69) of all the MCD fields, the second generation were collecting 75% (66 to 91), and the third-generation registries were collecting 85% (78 to 94).

**Compatibility with MCD core fields.** Five of the 20 core fields were collected by all 17 registries (age, sex, date and time of operation, type of surgery, and death during acute hospital admission). Two other fields were collected by 16 registries (date and time of presentation with hip fracture and American Society of Anesthesiologists (ASA)<sup>29</sup> grade), and five more fields by 15 registries (fracture type, fracture side, pathological nature of fracture, type of anaesthetic, and discharge destination). Only three core variables were each collected by less than two-thirds (11/17) of the registries: prefracture mobility/activities of daily living (ADLs), cognition on admission, and bone protection medication prescription at discharge. A detailed comparison of each registry with the 2022 MCD is given in Tables I and II, with a detailed comparison of each registry in Supplementary Figure c.

**Compatibility with MCD optional fields.** Overall, 13/17 (76%) registries collected data relating to the use of bone protection

**Table I.** Proportion of national registries collecting each field of the dataset.

Variable	%
Patient consent	41
Audit number	100
Hospital code	100
<b>Core dataset fields</b>	
Sex	100
Age at event	100
Pre-fracture residence	82
Date and time presented with hip fracture at operating hospital	94
Pre-fracture mobility/ADLs	65
Cognitive status	65
ASA grade	94
Side of fracture	88
Pathological fracture	88
Fracture type	88
Operation performed	100
Date/time of primary surgery	100
Type of anaesthesia	88
Pressure ulcer developed during this admission	82
Physician/geriatrician involvement	82
Out of bed postoperatively	82
Death during acute hospital admission	100
Date/time of discharge from acute care	82
Acute discharge destination	88
Bone protection medication at discharge	65
<b>Optional dataset fields</b>	
Date/time of trauma causing hip fracture	47
Date/time of admission to orthopaedic/orthogeriatric ward	59
Pre-fracture bone protection medication	76
Nutritional assessment performed on admission	47
Date/time of discharge from post-acute care	29
Post-acute discharge destination	41
Alive at end of this audit's follow-up period	94
Reoperation within this follow-up period	94
Mobility at end of this follow-up period	82
Residence at end of this follow-up period	76
Bone protection medication at end of this follow-up period	82

ADLs, activities of daily living; ASA, American Society of Anesthesiologists.

medication pre-fracture. Around half the registries collected time of admission to a definitive orthopaedic/orthogeriatric ward (10/19; 59%), date and time of fracture (8/17; 47%), pre-fracture nutritional assessment (8/17; 47%), and discharge destination following the subacute/step-down care episode (7/17; 41%). Only 5/17 (29%) audited the date of discharge from following the subacute/step-down care episode. A detailed breakdown is presented in Supplementary Figure c.

**Follow-up outcome measurement.** Overall, 16/17 (94%) of the registries assessed outcomes in some form after a defined period of follow-up. It should be noted that this refers to the collection of audit data (e.g. to determine survival or performance), rather than clinical follow-up which would involve a medical assessment of the patient by a clinician, either in person or remotely. Follow-up durations ranged from 30 to 365 days following fracture, with the most common timepoints being 120 days (10/17; 59%) and 30 days (8/17; 48%) post-fracture.

**Table II.** Proportion of Minimum Common Dataset fields and follow-up period used by each registry.

Registry	Proportion of fields, %	Follow-up period, days after fracture
Argentina	84	120
Australia and New Zealand	72	120
China	91	30, 120
Denmark	59	30
England, Wales, and Northern Ireland	91	30, 120
Germany	75	120
Holland	72	70 to 120
Ireland	66	None
Japan	84	30, 120, 365
Mexico	78	30
Norway	53	120
Pakistan	78	30
Philippines	94	120
Scotland	66	30
South Korea	88	30, 90
Spain	81	30
Sweden	69	120

There were 4 (24%) registries conducting follow-up at multiple timepoints. A detailed breakdown is presented in Supplementary Figure c.

The frequency with which registries collect the five optional fields that relate to follow-up data was high. A total of 16/17 (94%) collect data regarding deaths or reoperations that occurred by their defined follow-up timepoint, while 14/17 (82%) collected mobility status and bone protection medication prescription, and 13/17 (76%) audited patient residence type.

## Discussion

This study evaluated the compatibility of all 17 national hip fracture registries using the Fragility Fracture Network 2022 Minimum Common Dataset (MCD) as the internationally agreed benchmark. Overall, 17 of the 20 core fields were collected by the majority of registries, demonstrating high levels of consistency between national programmes. However, there was poorer collection of clinical data pertaining to prefracture mobility and functional status, prefracture cognitive assessment, and bone protection medication use. All but one registry collected data at defined follow-up timepoints, but there was variability in the chosen duration of follow-up.

Overall compatibility with the MCD was highest in the recently established third generation of registries, second highest in the second-generation registries, and lowest among the oldest programmes. The high levels of compatibility between the MCD and the newest registries may reflect the influence of the recent publication of the 2022 MCD.<sup>15,30</sup> Most of these newer registries were designed before the updated MCD was published, but the process of generating the new MCD was undertaken in public through established FFN channels, and it is likely that this increased the compatibility of the newest programmes.<sup>17</sup> The 2022 iteration of the MCD was designed to reflect the priorities and realities of data collection for patients with hip fractures around the world, as opposed to those in developed healthcare

economies such as Europe. It is interesting that, even though the registry leads from the older programmes were involved in the 2022 revision of the MCD, their registries lag behind newer registries in terms of compatibility with the common dataset. This may simply reflect how long it would take to adjust a dataset to adhere to the new MCD, or it may reflect entrenched practice within well-established registries that have evolved to meet the specific priorities of their local health system.

Regarding individual data points, the most marked inconsistency in datasets was apparent for three core MCD fields, including two that related to initial patient assessment. Assessment of prefracture mobility or function, and prefracture cognitive status, are key aspects of initial clinical assessment in the hip fracture population and have significant implications on decisions regarding surgical management, rehabilitation, and discharge planning.<sup>31</sup> They are also effective markers of frailty, which is known to affect patient outcomes, and should therefore be included as baseline risk factors in order to make informed comparisons on an inter-patient, inter-hospital, and inter-system level.<sup>31–35</sup>

There was little consensus on the assessment of mobility pre- or postinjury, and the length of audit follow-up was variable. Five of the established registries assessed prefracture function in terms of the use of mobility aids prior to the injury, while others prioritized the classification of independence with ADLs such as personal care and household chores. Prefracture mobility has been shown to correlate with post-fracture outcomes and standardized assessment has been validated in hip fracture, for example with the New Mobility Score.<sup>36,37</sup> Assessment of prefracture mobility status also provides a simple way to evaluate pre-morbid function as an indicator of quality of life, in lieu of more complicated and resource-dependent patient-reported outcome measures. This information is also useful to guide surgical decision-making (e.g. implant choice for hip arthroplasty), postoperative physiotherapy and occupational therapy interventions, and post-discharge rehabilitation.<sup>37,38</sup> Similarly, only nine registries recorded whether patients could mobilize on the first postoperative day, which is thought to be of benefit to facilitate rehabilitation and prevent complications such as respiratory infections, pressure ulcers, venous thromboembolism, inactivity-related sarcopenia, and institutionalization. Return to a pre-morbid level of function is of huge importance to the patient and their carers, and is a determinant of ongoing health and social care requirements. As such, this might be considered a key performance indicator of a hip fracture services, yet fewer than half of the registries collected data to evaluate successful return to baseline function.

The mode of assessment of baseline cognition varied between the nine registries that collected this information. The most widely used tool at initial assessment was the Abbreviated Mental Test (AMT),<sup>39</sup> though some simply recorded any suggested history of dementia. There is growing appreciation that the high prevalence of delirium in the acute hip fracture setting, and its harmful effect on outcomes may justify the inclusion of the 4As Test (4AT) as a baseline assessment. This is the case for all patients admitted in Scotland, and the test is also used as a postoperative tool throughout the UK.<sup>40–42</sup> The impact of cognition (including prefracture cognitive impairment and

perioperative delirium) on hip fracture outcomes is an area that requires major investigation, and this could be facilitated with increased consistency of definitions and assessment methods across hip fracture audits.<sup>43</sup>

Increasing emphasis on the use of pharmacological bone protection in osteoporosis is reflected in the finding that 11 registries collected data pertaining to pre-fracture medication use, although only nine recorded post-fracture medication prescriptions, and approaches to data recording also varied.<sup>44</sup> Regular and consistent collection of this information within hip fracture audits is essential if effective national strategies for the prevention of future fractures are to be established for this high-risk patient population.

Of the 17 registries, 16 collect data at a defined non-clinical follow-up point, with the most common durations of follow-up being 30 or 120 days postinjury. Four collected data at multiple timepoints, which can increase the resolution of data that can otherwise be restricted by binary coding of outcome variables. The choice of follow-up duration reflects the practicalities of the respective programmes and their mechanisms for data collection, as well as the differential prioritization of early outcome data such as early death, readmission, or reoperation (which are often considered within 30 days of admission), or late outcome data such as the recovery of mobility, independence, and health-related quality of life (which are usually considered to plateau at around 120 days after admission).<sup>45</sup> Data collection at 120 days is more challenging but can provide valuable patient-centred information, as well as vital metrics to help guide broader health and social care service design.

The three items where compatibility was found for less than two-thirds of registries are ones that are crucial to the delivery of effective hip fracture services. It appears that individual regions are addressing these areas in a bespoke manner, appropriate to the health systems that they serve. However, greater compatibility of datasets, aligned to a global standard, would increase interoperability of registries and enhance their functionality in terms of international benchmarking, research, responses to supraregional issues, and improvements in the diversity and generalizability of lessons learned in hip fracture care.<sup>15,46,47</sup> The process of continuous healthcare audit, where multiple aspects of a health system are monitored and improved, is associated with higher-quality care and improved patient outcomes.<sup>1,3,4,48</sup> The ability to make intelligible comparisons of service performance indicators and patient outcome measures between health systems could help different countries to learn from each other's experience and quality improvement initiatives, as well as from variations in clinical practice and governance strategies.<sup>2,7</sup>

The impact of hip fracture research could be increased through the compilation of larger datasets containing greater diversity and granularity. These could be examined to produce higher-quality observational studies, or integrated with medical informatics and health data science techniques to examine complex interactions using the meta-audit process.<sup>16</sup> This is already being realized for hip fracture through the digital assimilation of registries by the European Health Data Evidence Network (EHDEN).<sup>49</sup> The core fields of the 2022 MCD are being mapped to the Observational Medical Outcomes Partnership common data model following a successful grant from

the EHDEN initiative.<sup>50,51</sup> This will assist registry data partners to compare temporal and geographical trends in hip fracture care, undertaking large-scale federated network analyses on a global scale.

Embedding experimental studies in routinely collected health datasets was established in hip fracture with the WHiTE collaboration, and the generalizability of such studies could be increased with larger cohorts covering a broader clinical and geopolitical context.<sup>38,52–54</sup> Lastly, greater interoperability of existing registries was identified as a key area to improve during the COVID-19 pandemic, when a bespoke international research collaborative was required to examine important questions on a supraregional scale.<sup>55,56</sup> The use of established registries with in-built compatibility would reduce project lead time and harness the power of existing data collection and processing mechanisms to facilitate a more comprehensive global response to urgent threats.

There are several strengths to this study. A number of national hip fracture registries have been established recently, and this is the first published analysis of the approaches adopted by these programmes. The findings of the study provide information relating to the impact of the recent 2022 MCD introduction as an international standard dataset. The main limitation of the current study is that it was beyond the investigative scope to examine and compare the data elements collected by the national programmes that do not relate to a core or optional field on the 2022 MCD. The extent of such additional information is huge; 260 potential aspects of case-mix, care, and outcome measures were being collected by the eight national registries that were in existence in 2017, and this figure will have increased with the significant expansion in registries since then.

The complexity of this field is such that further work examining the collection of hip fracture data should focus on individual components of the care process which are linked to improved longer-term outcomes. For example, the recording of: comprehensive assessment of frailty, comorbidity, and prefracture function; pre-existing and inpatient cognitive assessment (including routine screening for delirium); surgical, anaesthetic, and perioperative factors; postoperative rehabilitation and recovery; and outcome measures that are patient-centred and useful for service delivery and planning.<sup>57</sup>

Further work is also needed to examine how each registry addresses the healthcare system it serves, and how the practicalities in different regions influence the mode and format of data collection. Finally, the dynamic nature of this field is self-evident, with two new pilot registries set up during the data collection for this study, and another since its completion. The pace of this change emphasizes the importance of this work, but provides challenges in keeping the picture we describe up to date, as new audits are set up and existing registries are modified to address changes in health services around the world.

The number of national clinical registry programmes is increasing to meet the demands of the rapidly growing global challenge of hip fracture. There was reasonable compatibility between the ten established registries and the recently published FFN 2022 MCD. There was greater compatibility among the more recently established programmes, which is possibly a reflection of their ability to deliver bespoke data collection

mechanisms in line with current trends in hip fracture audit. However, there is scope to improve the interoperability of national hip fracture registries in line with this global standard. This would enhance their functionality in terms of international benchmarking, research, responses to supraregional issues, and improving the diversity and generalizability of lessons learned through innovation and experience.



### Take home message

- A total of 20 countries now have national hip fracture registries, and new countries are increasingly using the Fragility Fracture Network minimum common dataset as a framework upon which to build their own.
- This study aims to help countries collect data consistently, so it can be used in international comparisons, and we can learn from each other's experience.

### Twitter

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### Supplementary material



Figures showing the core and optional fields of the Fragility Fracture Network 2022 Minimum Common Dataset, as well as a detailed comparison of each registry.

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