EE114

Reductions in Travel Time and CO_2 Emissions Arising from Patient Transportation to Hospitals in Ireland for Treatment with Intravenous Iron: An Analysis Comparing Ferric Derisomaltose with Ferric Carboxymaltose

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Background

Reducing the number of patient interactions with the healthcare system (particularly hospital appointments) has significant advantages, provided an optimal level of healthcare is still delivered. Some benefits include a reduction in the following: demand for constrained resources (staff time, equipment, and facilities), risk of exposure to nosocomial infections, patient inconvenience, travel time and travel-related carbon dioxide (CO_2) emissions. Avoiding such factors can also improve patient quality of life.[1]

Some broader, large scale healthcare initiatives have been implemented in an attempt to reduce unnecessary patient interactions with the healthcare system, (e.g., closer health and social care integration, primary and secondary care integration, increasing adoption of telemedicine, and implementation of "hospital-at-home" schemes).[1] However, when considering approaches that are treatment-centric for specific diseases, fiscally prudent formulary management can be effective in minimizing outpatient appointments and elective admissions.

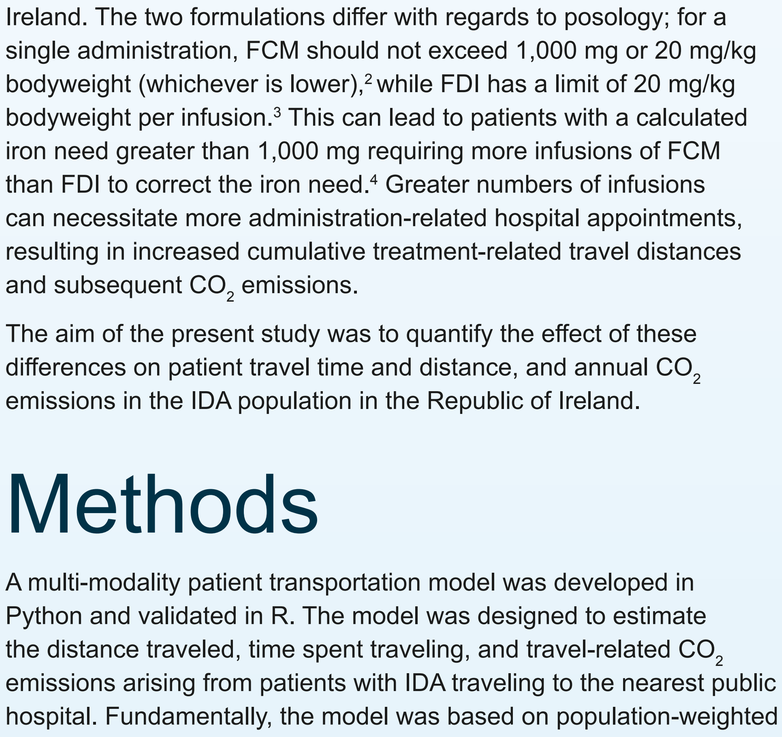
Iron deficiency anemia (IDA) is one such disease where the number of patient interactions with the healthcare system can be affected by formulary decisions. In patients with IDA, intravenous (IV) iron is the preferential treatment option when oral iron is contraindicated, not tolerated, or ineffective, or when rapid iron replenishment is required. Ferric derisomaltose (FDI) and ferric carboxymaltose (FCM) are two high-dose, rapid-infusion IV iron formulations available in Ireland. The two formulations differ with regards to posology; for a single administration, FCM should not exceed 1,000 mg or 20 mg/kg bodyweight (whichever is lower),[2] while FDI has a limit of 20 mg/kg bodyweight per infusion.[3] This can lead to patients with a calculated iron need greater than 1,000 mg requiring more infusions of FCM than FDI to correct the iron need.[4] Greater numbers of infusions can necessitate more administration-related hospital appointments, resulting in increased cumulative treatment-related travel distances and subsequent CO_2 emissions.

The aim of the present study was to quantify the effect of these differences on patient travel time and distance, and annual CO_2 emissions in the IDA population in the Republic of Ireland.

Methods

A multi-modality patient transportation model was developed in Python and validated in R. The model was designed to estimate the distance traveled, time spent traveling, and travel-related CO_2 emissions arising from patients with IDA traveling to the nearest public hospital. Fundamentally, the model was based on population-weighted calculations of the mean distance from each Irish "small area" (as defined by The National Institute of Regional and Spatial Analysis) to the nearest hospital at which IV iron is administered.

Figure 1. Geographical data underpinning the Irish transportation model



Blue squares represent public hospitals where IV iron is administered, and the gray boundaries (for information only) are the boundaries of the 18,627 "small areas" defined by The National Institute of Regional and Spatial Analysis.

Table 1. Annual projections of distance traveled, time spent traveling, and CO_2 emissions arising from trips to the hospital for intravenous iron infusions in the Republic of Ireland

Treatment	Travel distance in km (SD)	Travel time in hours (SD)	CO_2 emissions from patient travel in kg (SD)
Ferric carboxymaltose	992,465 (226,926)	19,756 (4,539)	182,900 (42,252)
Ferric derisomaltose	756,965 (173,079)	15,068 (3,462)	139,500 (32,226)
Difference with ferric derisomaltose	**-235,500 (53,847)**	**-4,688 (1,077)**	**-43,400 (10,026)**

Population data for 18,627 Irish small areas (Figure 1) were obtained from the 2016 census, which was published by the Central Statistics Office (CSO). Population data were then scaled up to 2022 estimates based on official population growth rates published by the CSO.

A list of Irish public hospitals was obtained from the Health Service Executive (Figure 1). The mean distance from the centroid of each small area to the nearest hospital was then calculated, weighted by the small area population, and adjusted using a calculated "detour index" to account for deviations from the straight-line distance between the centroids and the nearest hospital. The model was run over 1,000 iterations, with each iteration sampling from a normal distribution around the detour index.

Transport modality data were obtained from the 2019 National Travel Survey (NTS) published by the CSO, and used to model the utilisation of different transport modalities. Based on the NTS, 73.7% of patients travelled to their nearest hospital by car, 4.8% of patients by bus, 1.7% of patients by train, and 0.9% of patients by taxi. The remaining patient groups used either undefined CO_2-emitting modes of transport (3.6%) or non-CO_2 emitting modes of transport such as walking (13.5%) or cycling (1.5%), which were omitted from the CO_2 analysis.

Proxy CO_2 emissions data for each mode of transport were obtained from the UK Department for Business, Energy & Industrial Strategy in grams per passenger kilometre, specifically 192 g/km, 149 g/km, 104 g/km and 41 g/km for cars, taxis, buses, and trains, respectively.

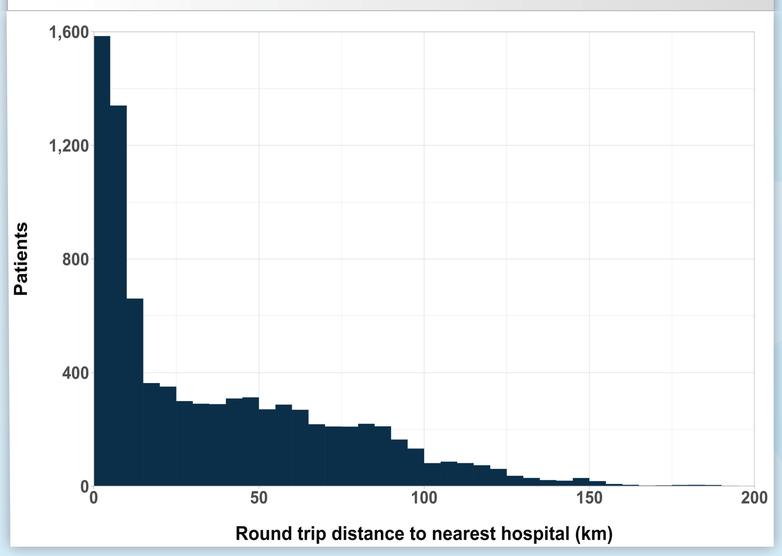
The mean number of infusions of FCM versus FDI was calculated using a published methodology.[5] Iron need was calculated based on a simplified table of iron need and patient characteristics were obtained from seven IDA trials (mean bodyweight of 82.4 kg [SD 22.5 kg] and hemoglobin levels of 9.99 g/dL [SD 1.03 g/dL]). The number of infusions was then combined estimated numbers of patients receiving IV iron annually, and incorporated into the transport model to calculate changes in patient travel distance, time, and CO_2 emissions associated with using exclusively FDI versus exclusively FCM.

Results

The Irish IDA population currently receiving IV iron therapy was estimated to be 8,570 per annum and the base case analysis was conducted based on one IV iron treatment course per patient. The average travel distance to the nearest hospital across all Irish small areas was 20.1 km (40.2 km per round trip; Figure 2).

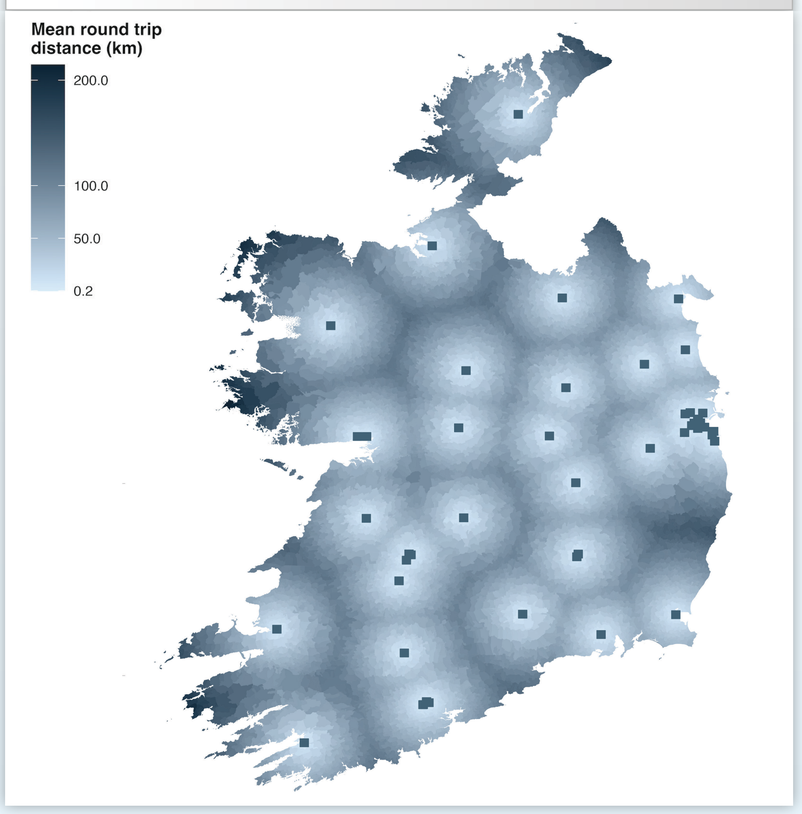
The average travel distance to the nearest hospital was significantly shorter in small areas located within or nearby major cities such as Dublin. However, in small areas located in regions such as the south-west, north-west and south-east of Ireland (where there is a relative scarcity of public hospitals), the average travel distance to the nearest hospital was significantly longer (Figure 3).

Figure 2. Number of patients by the estimated round-trip distance to the nearest hospital



FDI would reduce mean iron infusions per treatment course by 0.42 from 1.77 to 1.35 (23.7%) versus FCM. Based on a multi-modality transport model to Irish hospitals, FDI was projected to reduce the mean total annual distance travelled by 235,500 km (standard deviation [SD]: 53,847) from 992,465 km (SD: 226,926) to 756,965 km (SD: 173,079) versus FCM, saving 4,688 hours (SD: 1,077) of patient time and 43,400 kg (SD: 10,026) of CO2 emissions (Table 1).

Figure 3. Small areas shaded by mean round-trip distance to the nearest hospital administering intravenous iron



Conclusion

Compared with FCM, FDI reduced the number of IV infusions required in patients with IDA in the Republic of Ireland, resulting in associated reductions in patient travel time, distance, and CO_2 emissions.

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Acknowledgement

This study was sponsored by Pharmacosmos A/S.

Poster presented at **ISPOR Europe 2023**
November 12-15, 2023
Copenhagen, Denmark