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Original Article

Intermediate Care Units in Internal Medicine

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ABSTRACT

Background: Intermediate Care Units (ImCU) have been historically described as an intermediate level of care between standard wards and intensive care units (ICU), and general medical ImCUs have evolved as specifically addressed to high care medical patients. The objective of this study is to explore designs, appropriateness criteria, and quality of care of general medical ImCUs.

Methods: a comprehensive literature search was performed in electronic database (PubMed/Medline, Embase, Cochrane and Web of Science) up to July 30th 2024 and data about general medical ImCU denominations, settings, processes and outcomes were extracted.

Results: 34 studies were included in systematic analyses, the more used nomenclature was ImCU (70.6 %), followed by High Dependency Unit (20.6 %). The median number of beds was 8 [4–11], the nurse-to-patients ratio 1:3.1, and internists involved in comanagement in 40.0 %. Either a step-up from standard wards or a step-down from ICUs role were reported, with a median of 50.8 % [26.2–71.0] of patients directly admitted from Emergency Departments. The main distinctive activities were continuous monitoring and non-invasive ventilation. The median ICU transfer rate was 8.0 % [5.6–12.3], while in-ImCU and in-hospital mortality were 6.2 % [3.6–8.3] and 14.0 % [8.7–19.1], respectively.

Conclusions: general medical ImCUs are being increasingly recognized as the appropriate setting for high care medical patients but present to date a wide variability of formats. Activity-based admission criteria tailored on each hospital reality could be a process model for adequate patient flow, and quality of care key indicators should consider the functional general medical ImCU role in hospital macro-systems.

1. Introduction

A cornerstone of the reorganization challenge of hospital systems has been provided by the Progressive Patient Care (PPC) model [1], lying on the concept of pooling patients around the acuity of their conditions and not around the specialty they are concerned with, by classifying them on medical and nursing needs to define the different levels of care and the appropriate correspondent settings [2,3].

Traditionally, hospital management has been divided into specialist areas and not stratified by levels of care, with a potential mismatch between the punctual patients' needs [4] and the settings where care is provided.

According to PPC model and overcoming a merely disease-centred approach, the definition of high care patients refers to those with active acute and/or acute on chronic problems who need high level clinical and/or nursing care due to their severity of illness and complexity, requiring high level of staffing and technological resources to guarantee the adequate quality of care [5,6].

Specifically destined for high care patients, Intermediate Care Units (ImCU) have been intended as intermediate settings of care between standard wards and intensive care units (ICU) and defined as organ monitoring and support units, in contrast to the organ replacement role of ICUs [3,4,7–9].

The in-hospital critical care can be viewed as a chain linking standard wards to ICUs [10–11] through ImCUs, intended for patients admitted from Emergency Departments (ED), stepping down from ICUs or stepping up from wards, with a middle position in the grey zone between intensive and standard care levels [12].

In literature the guidelines on ImCU admission and discharge have historically provided criteria targeted on specific medical and surgical conditions or on physiologic stabilization no longer requiring active life-support in ICUs [13,14], tracing the too well (and stop ICU stay need) -

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too sick (and ICU transfer need) concept [15], but they are limited by missing a univocal definition of how ImCUs should be formatted and staffed, what specific monitoring and treatments delivered, and which patients admitted [8].

Hospital organization is, by its nature, complex, and ImCU formats vary considerably between institutions, suggesting that "one size does not fit all".

Beginning with nomenclature, there are multiple ImCU designations contributing to blur their identity: Intermediate Care, High Care, High Dependency, Progressive Care, Step up, Step down, Transitional Care, Medium Care, Sub-intensive Care, or Semi-intensive Care Unit [9,16].

In 2017 a systematic review [8] reported that the 51.4 % of ImCUs treated only surgical patients [17–22], 35.1 % treated both surgical and medical patients and 10.8 % treated only medical patients.

Two kinds of medical ImCUs have been recognized: the specialistic ones, dedicated to easily recognisable patients with a mono-specialistic active health problem (e.g., stroke units [23], coronary care units [24, 25], respiratory intermediate care units [26–31]), and the general medical ImCUs, characterized by an extremely variable case mix and pivotal point for high care complex medical patients.

Despite evidence that care settings per se affect clinical risk [32], interventions as ventilation or vasopressor therapy are commonly delivered in unmonitored general medical wards, suggesting the need to increase the number of beds dedicated to deliver high care treatments [33] and the general medical ImCUs have arisen to provide appropriate care to the increasing number of acute and complex patients, often but not exclusively poli-pathological and elderly, generally destined to Internal Medicine units regardless of their clinical needs.

Many studies have been focused on specific disease-targeted medical population, as sepsis [34–36], acute respiratory failure [37], kidney injury [38], liver failure [39,40], heart failure [41], ketoacidosis [42], or stroke [43], revealing the high level of care ensured by general medical ImCUs, whereas structures, processes and outcomes are still now poorly defined.

During COVID-19 pandemic, in response to necessary new policies for stressed healthcare systems, several hospitals have created new respiratory but frequently general medical ImCUs, in many cases extending pre-existing ones or up-grading medical wards, especially the Internal Medicine units, enhancing the involvement of internists in the interdisciplinary management of SARS-CoV-2 patients with acute respiratory failure needing non-invasive ventilation as a prototype of high care medical patients [44–46].

Since good structures lead to good processes which in turn lead to positive outcomes [47], the ImCU characteristics of interest to evaluate their identity could be traced back to these topics: structures, processes and outcomes.

The aim of this study is to provide an up-to-date literature review focused on general medical ImCUs to fill in the gap on their appropriateness criteria and quality of care.

2. Materials and methods

A literature review was conducted based on the Preferred Reporting Items for Systematic Review and Meta-Analyses (PRISMA) methodology. General medical ImCUs were the topic of interest and, following the PICOS format, populations (P) were non-selected adult patients in medical ImCUs; interventions (I) were admissions in a general medical ImCU; comparators (C) were not preliminary defined; outcomes (O) included those related to ImCU exposure, as timing, destination or mortality. The only restriction to study designs (S) was the absence of original data **[Suppl. 1]**.

2.1. Eligibility criteria and study characteristics

All indexed original articles describing general medical ImCUs were considered, excluding reports on maternal/gynaecological, neonatal/paediatric or psychiatric ImCUs.

Studies referred to Intermediate Care as post-acute or transitional settings between hospital and homecare or nursing-home were eliminated during the screening process.

The search was performed without language or publication data restrictions. The inclusion/exclusion criteria, filters and items of interest were formalized to minimize the risks of missing data and discrepancies **[Suppl. 1]**.

2.2. Information sources

A scoping search was undertaken on indexed literature to identify key terms like "Intermediate Care" and to trace the principal topics reported in describing ImCU structures, processes and outcomes to be considered in data extraction.

The explorative research showed a weakly controlled vocabulary, and all articles were scrutinized for terms expressing "Intermediate Care Unit" or synonyms. The search string was made up of keywords reported in title/abstract and a comprehensive search in multiple electronic databases (PubMed/Medline, Embase, Cochrane and Web of Science) was performed up to July 30th, 2024 **[Suppl. 1]**.

2.3. Search strategy and selection process

A combination of reported search-terms adopting Boolean operators were applied on each database. Grey literature was not considered. Duplicates were removed and two reviewers (C.C. and S.A.) independently screened all remaining retrieved articles on title and abstract, while a third author (F.S.) reviewed methodology; if considered necessary the whole article was checked for, and disagreements were settled by consensus.

The selection process excluded studies referred to primarily surgical/trauma or post-operative/post-anaesthesia ImCU and to medical monovalent specialistic (as coronary or respiratory ones) ImCUs.

Studies referred to selected disease-target medical ImCU population were considered but not analysed.

The full texts of non-excluded studies entered in systematic analysis if matching the established inclusion/exclusion criteria **[Suppl. 1]**.

2.4. Data extraction and data analysis

A worksheet was used for data extraction and a descriptive synthesis was performed without assumptions about missing or unclear qualitative information and quantitative variables. Heterogeneity across studies turned out to be excessive to perform meta-analyses computing relative risks using random-effects model but the risk of biases in individual studies did not influence the objective of the study. When appropriate, categorical variables were expressed as frequencies and percentages, while continuous variables were reported as median [IQR and min-max range].

3. Results

3.1. Study selection and characteristics

A total of 7287 articles were identified through databases search and, after screening, 34 studies full matched inclusion criteria. The selection process is depicted in the PRISMA diagram [Fig. 1].

The publication years varied from 1979 to 2024, while considering the country of origin the majority were European studies (21/34, 61.8 %), followed by USA (8/34, 23.5 %); the remainders were from Israel (two), Australia (one), Hong Kong (one) and Kenya (one). As for nomenclature 24/34 (70.6 %) studies referred to Intermediate Care, 7/34 (20.6 %) to High Dependency (in UK and Australian studies), followed by Sub-Intensive (one, Italy), Medium Care (one, Netherlands) and Progressive Care Unit (one, USA).

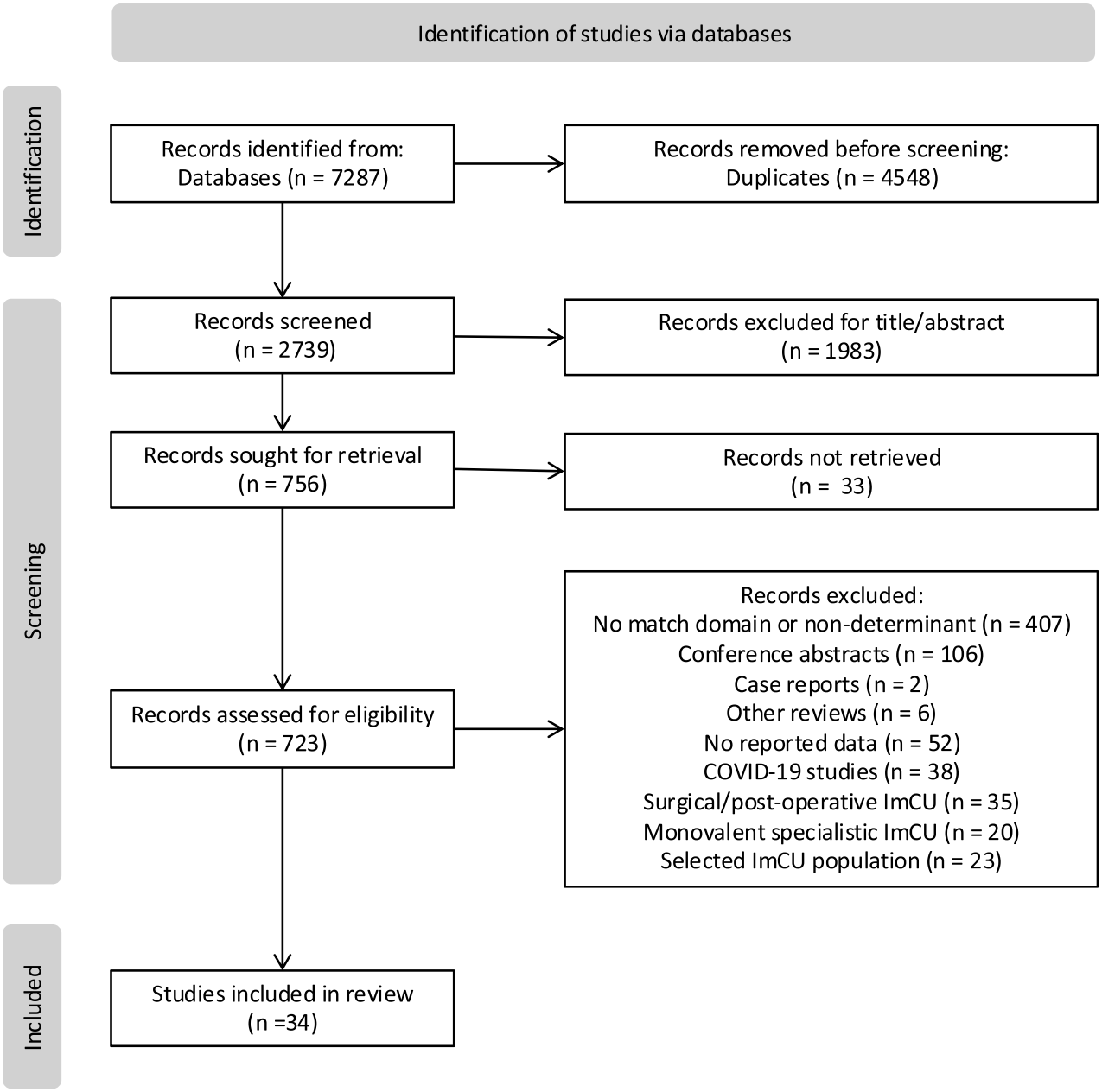

Fig. 1. PRISMA flow diagram for study selection.

The sample size of the ImCU populations varies from 33 to 9008 patients, median 454 [IQR 295–1006].

In four cases the same unit was described in multiple articles by the same group of authors but with differences in sample sizes and variables or in publication years, at the Johns Hopkins University, Baltimore (USA) [48–51], the Clinica Universidad de Navarra, Pamplona (Spain) [52–54], the São Francisco Xavier Hospital, Lisbon (Portugal) [55,56], and the Akershus University Hospital, Oslo (Norway) [57,58]. The multiple studies referring to a single centre but with different characteristics were presented separately but considered as one unit in following aggregated results referring to the most detailed one.

Data related to ImCU settings (number of beds and location), hospitals' characteristics, nurse-to-patient ratios, physicians' specialties, clinical activities, scoring systems, sample size, patient inflow, and outcomes were outlined in Table 1.

3.2. Setting

The number of beds was reported in 30/34 studies (88.2 %) and ranged from 3 to 21 beds, with a median of 8 beds [IQR 4–11]; European ImCUs appeared to have fewer beds (7.5 [4–10.5]) compared to USA ones (10 [6-12]).

The ImCU location was considered in 23/34 (67.6 %) articles, of these 6 (26.1 %) units were located adjacent to ICU, 2 (8.7 %) integrated in ICU, 2 (8.7 %) adjacent to medical ward, 6 (26.1 %) integrated in medical ward, and in 4 (17.4 %) studies were presented separated, stand-alone units.

Interestingly, older studies described ImCUs located with reference to ICUs while the more recent ones, published after 2020, described ImCUs integrated in medical wards. The ImCUs integrated in medical wards had a median of 4 beds, while those separated or adjacent to medical wards had on average a larger size (12 beds).

Table 1
Summary of study characteristics of general medical Intermediate Care Units.

First Author Pub. year [ref] Country Unit name	ImCu Settings: n° beds Location [hospital data] Staff: nurse:patients Physicians' specialty	Reported Clinical Activities Scores	ImCU Population [Overall study's sample Size, if larger]	Reported Outcomes
Le Gall JR 1979 [59] France	16 beds Integrated in ICU //	-Special techniques: Swan Ganz, ventilatory support, enteral nutrition, PM -Intensive techniques: IV-line, urinary output, arterial pressure	33 ImCU patients [100]	Immediate Survival Rate 95 % (66 % in ICU patients)
Intermediate Care Unit	nurse:patients 1:6 Intensivists	//		
Franklin CM 1988 [60] USA	12 beds // [280 general medical beds]	-Continuous arrhythmia monitoring -Cardiorespiratory continuous monitoring	1080 ImCU patients from ED or medical wards [22,998]	-ImCU Case Fatality Rate 2.1 -Overall Case Fatality Rate decreased from 4.5 % to 3.9 % in the first year
Intermediate Care Unit	nurse:patients 1:4 //	//		-Ward cardiac arrest decreased from 1.8 to 1 .1 % -ICU admissions decreased by 7.1 % (+33.3 % of ICU bed space)
Porath A 1995 [61] Israel	// // [810 beds medical centre]	//	119 ImCU patients from ED (80 %) or medical wards	-In hospital mortality 17.6 %
Medical Intermediate Care Unit	nurse:patients 1:3 //	APACHE II 12.9 TISS 12.6		
Thompson FJ 1995 [62] UK	Survey on 28 HDUs: 3–13 beds 82 % Separated from ICUs 39 % Integrated in acute general wards //	-Intra-arterial and central venous pressure -Continuous non-invasive monitoring -NIV -Invasive ventilation -Vasoactive drugs -Cardioversion and pacing -Hemofiltration -Analgesia/sedation	100–700 annual HDU step-up and step-down patients (74 % of HDUs admitting surgical patients)	-In HDU time of stay 1.5–7 days -Costs of ICU patient day 1148£ vs 437£ of HDU patient day
High-dependency Unit	nurse:patients 1:3 (at least) Surgeons and Intensivists	//		
Auriant I 1998 [63] France	4 beds Adjacent to ICU [694 beds multidisciplinary hospital]	-Continuous monitoring of vital signs -Central venous pressure	433 ImCU patients from ED (60.9 %), ICU (1.3 %), medical wards or other hospitals (4 % non-medical patients)	-In ImCU time of stay 3.1 ± 2.3 days -Direct discharge rate 27 % -ICU transfers 5 % -In ImCU mortality 2.7 %
Intermediate Care Unit	// Intensivists	SAPS II 22.3 ± 12		-In hospital mortality 8.1 %
Ip SPS 1999 [64] Hong Kong	4 beds // [200 beds geriatric acute care unit]	-Invasive monitoring -Invasive ventilation -Inotropic agents -Renal dialysis	150 gHDU patients from ED or acute hospital wards	-In gHDU time of stay 7.53 days -In hospital LoS 19.96 days -DNR 12 % -ICU transfer 0 %
Geriatric High-dependency Unit	nurse:patients 1:3.2 //	APACHE II 19.39 SAPS 12.6		-1-month mortality 48 % -Cost 1 GHDU bed-day was equivalent to 24 % of 1 ICU bed-day
Junker C 2002 [65] USA	// // //	-Monitoring -Active Life-Supporting Measures as: ventilation, vasoactive drugs, IV fluids, rapid blood transfusion, haemodialysis, cardioversion, endoscopy	8971 patients in 37 ICAs from ED (37.6 %), ICU (16.6 %), hospital wards, operating room or other hospitals (16.8 % surgical patients)	-In ICA time of stay 3.9 ± 3.1 days -In hospital LoS 8.9 ± 9.1 days -ICU transfer 1.1 % -In ICA mortality 1.1 % -In hospital mortality 3.1 %
Intermediate Care Area	nurse:patients < 1:2 //	APACHE II 16.7 ± 12.3 APACHE III 28.9 ± 15.5	[vs 5116 low-risk monitor patients in 59 ICUs]	
Ranhoff AH 2006 [66] Italy	4 beds Integrated in 24-bed acute medical unit for the elderly [340 beds general hospital]	-Non-invasive monitoring of cardiac and respiratory functions -NIV -IV- and enteral nutrition	401 SICU patients from ED (95 %), ICU (1 %) or hospital wards	-In SICU time of stay 61.8 ± 62.4 hours -In hospital LoS 6.0 ± 4.9 days -ICU transfer 3.5 % -In SICU mortality 7.7 %
Subintensive Care Unit	nurse:patients 1:4 Internal Medicine and Geriatric physicians	Charlson's index 6.5 ± 2 MMSE 19.1 ± 11 Barthel index on admission 28.8 ± 35.2 APACHE II 14.5		-In hospital mortality 12.5 %
Torres OH 2006 [67] Spain	20 beds Adjacent to ICU [600 beds acute care centre]	-Continuous monitoring -Arterial or central venous catheter -NIV -Inotropic agents	412 ImCU patients from ED (80.1 %), ICU (6.6 %), hospital wards or other hospitals (5.1–11.8 % surgical patients)	-In ImCU time of stay 3.6 ± 6.3 days -In hospital LoS 13.9 ± 14.2 days in < 65y 18.2 ± 19.7 in ≥ 65y -Number of 2-years later admissions 1.2 ± 2.1
Intermediate Care Unit	// //	Reported as < 65y vs ≥ 65y: Charlson's index 1.5 ± 2.1 vs 2.1 ± 1.8 Barthel index 95.2 ± 17.6 vs 89.6 ± 19.4 APACHE II 9.8 ± 5.9 vs 14.1 ± 5.7 TISS-28 18.7 ± 8.1 vs 20.5 ± 7.9		-In ImCU mortality 7.8 % -In hospital mortality 14.1 %

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Table 1 (*continued*)

First Author Pub. year [ref] Country Unit name	ImCu Settings: n° beds Location [hospital data] Staff: nurse:patients Physicians' specialty	Reported Clinical Activities Scores	ImCU Population [Overall study's sample Size, if larger]	Reported Outcomes
Alfonso-Megido J 2007 [68] Spain	6 beds Adjacent to Internal Medicine [non-ICU hospital]	-ECG monitoring -NIV -Starting invasive ventilation -Central IV-line -Pace-maker	453 ImCU patients from general wards	-In ImCU time of stay 2.4 days -Direct discharge rate 9 % -ICU transfer 9 % -In ImCU mortality 5 %
Intermediate Care Unit	nurse:patients 1:3–4 Internal Medicine physicians	SAPS II 34.7		
Heras A 2007 [69] Spain	4 beds Adjacent to 15 ICU beds [540 beds teaching hospital]	//	783 ImCU patients (13.6 % surgical patients) [3392]	-In ImCU time of stay 3.1 ± 3.5 days -In ImCU mortality 3.8 % -In hospital mortality 6.5 %
Intermediate Care Unit	// //	SAPS II 21.8 ± 11.6 MPM II_0 14.7 ± 12.4 NEMS 34.8 ± 6.5		
Gould A 2010 [70] Australia	8 beds Adjacent to ICU //	-Invasive hemodynamic monitoring -NIV -Inotrope infusion	154 HDU patients from ED (26.6 %), ICU (6.5 %) or hospital wards (28 % surgical patients) [tot 1145 HDU patients and 928 ICU patients]	-ICU transfer 6.7 % For ICU transferred patients: -Weekend admission 26 % -24:00–08:00 admissions 14.3 % -In hospital LoS 26.6 [8-38] -In-hospital mortality 26.8 %
High-dependency Unit	nurse:patients 1:2 Intensivists	For ICU transferred patients: APACHE II 21.1 [16-25] SOFA 7.2 [4-10]		
Duque S 2011 [55] Portugal	4 beds // [900 beds university hospital]	//	288 ImCU patients from ED, ICU and Internal Medicine ward	-In ImCU time of stay 11.3 ± 10 vs 8.4 ± 7 days -In ImCU mortality: 9.3 % vs 3.6% -In hospital mortality 25 % vs 6.3 %
Medical Intermediate Care Unit	// //	Reported as ≥ 65y vs < 65y: Charlson's index 7.4 ± 2.7 vs 2.4 ± 2.5 Barthel index 76.5 ± 31.4 vs 91.7 ± 23.2 APACHE II 17.8 ± 5.9 vs 9.6 ± 4.8 SAPS II 38.2 ± 8 vs 21.3 ± 8.5 SOFA 5.5 ± 2.3 vs 4.5 ± 2.2		
Lucena JF 2012 [54] Spain	9 beds Adjacent to mixed ICU [300 beds academic medical centre]	-Continuous telemetry, pulse oximetry, non-invasive arterial blood pressure -Central venous pressure monitoring -NIV	456 ImCu patients from ED (21.1 %), ICU (13.8 %), general wards, operating room or other hospitals (27.7 % surgical patients)	-Direct discharge rate 0.2 % -ICU transfers 14.3 % -In hospital mortality 20.6 %
Intermediate Care Unit	nurse:patients 1:3 Hospitalist-led, co-managed with Surgeons	SAPS II 37 ± 12		
Lucena JF 2013 [52] Spain	9 beds Adjacent to mixed ICU [300 beds academic medical centre]	-Continuous telemetry, pulse oximetry, non-invasive arterial blood pressure -Central venous pressure monitoring -NIV	607 ImCU patients from ED (24.9 %), ICU (14 %), general wards, operating room or other hospitals (13 % surgical patients)	-ICU transfers 12.3 % -In ImCU mortality 5.9 % -In hospital mortality 22.9 %
Intermediate Care Unit	nurse:patients 1:3 Hospitalist-led, co-managed with Surgeons	SAPS II 36.6 ± 11.9 SAPS 3 58.4 ± 15.4		
Alegre F 2015 [53] Spain	9 beds Adjacent to ICU [300 beds academic medical centre]	-Continuous non-invasive monitoring -Central venous pressure monitoring -NIV -Vasoactive drugs	743 ImCU patients from ED (27.1 %), ICU (13.1 %), general ward, operating room or other hospitals (11.3 % surgical patients)	-In ImCU time of stay 4 [2-7] days -Direct discharge rate 1.7 % -DNR 19.7 % -ICU transfer 10.0 %
Intermediate Care Unit	nurse:patients 1:3 Hospitalist-led	SAPS II 33.1 ± 12.9 SAPS 3 60.3 ± 14.0 ImCUSS 21.9 ± 16.1		
Armstrong E 2015 [71] Netherlands	9 beds Integrated in ICU [university medical centre]	-Hemodynamic monitoring excluding Swan-ganz -Intracranial pressure monitoring -NIV -Vasoactive and inotropic drugs -Sedation with continuous infusions	87 MCU patients from ED (18 %), ICU (36 %), both medical and surgical wards and recovery room (40 % surgical patients)	-In MCU time of stay 17–148 hours -In MCU mortality 3 % -In hospital mortality 13 %
Medium Care Unit	nurse:patients 1:2–3 Intensivists	APACHE II 11 ± 5 NAS 43.9 ± 13.2		
Fernandes L 2015 [56] Portugal	4 beds // [900 beds university hospital]	//	288 ImCU patients from ED, ICU, medical and surgical wards	-In ImCU time of stay 10.18 ± 9.07 days -In ImCU mortality 9.38 % -In hospital mortality 17.71 %
Medical Intermediate Care Unit	// //	Charlson's index 5.49 ± 3.57 Barthel index pre-admission 82.83 ± 29.58 APACHE II 14.79 ± 6.84 SAPS II 31.85 ± 11.70 SOFA 5.13 ± 2.31 TISS-28 21.84 ± 6.21 NAS 53.51 ± 16.99		

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Table 1 (*continued*)

First Author Pub. year [ref] Country Unit name	ImCu Settings: n° beds Location [hospital data] Staff: nurse:patients Physicians' specialty	Reported Clinical Activities Scores	ImCU Population [Overall study's sample Size, if larger]	Reported Outcomes
Prin M 2015 [72] UK	6 [4-8] beds 11 stand-alone HDUs [university, university -affiliated and non-university hospitals]	-Monitoring with arterial line -NIV	9008 HDU patients from ED (10.8 %), ICU (22.4 %) and general wards (40.7 % surgical patients)	-In HDU time of stay 1.8 [0.9–3.5] days -In hospital LoS 14 [7-28] days -Nighttime hours admission 44.1 % -Weekend admissions 19.4 % -ICU transfer 8.5 %
High-dependency Unit	// Intensivists, non-Intensivists or mixed physicians	ICNARC 12 [5-27]		-In HDU mortality 5.1 % -In hospital mortality 14.8 %
Yoo EJ 2016 [73] USA	10 beds First adjacent to ICU, then separated [academic hospital]	-Invasive central venous and arterial blood pressure (monitoring more frequently than every 2 h not permitted PCU admission) -NIV -Invasive ventilation	318 PCU patients from ED (first 25.9 %, then 44.6 %), ICU (first 60.8 %, then 41.7 %) and floors (first 37.8 %, then 13.1 % surgical patients)	-In hospital LoS first 20.8 ± 21.8, then 16.3 ± 23.5 days -Direct discharge rate first 23.0 %, then 41.1 % -DNR/DNI first 9.7, then 12.6 % -ICU transfer first 7.7 %, then 4.0 %
Progressive Care Unit	nurse:patients 1:3–4 Intensivists first, then Internal Medicine hospitalists	MPM_0-III first 9.1 ± 11 %, then 8.6 ± 10.3 % TISS-28 first 6.6 ± 2.8, then 5.8 ± 2.5		-In PCU mortality first 10.5 %, then 8.6 % -In hospital mortality first 11.9 %, then 9.1 % -No evidence that intensivist physician staffing improves outcomes for PCU patients
Duarte JA 2017 [74] Portugal	// Integrated in a medical ward	-NIV -Continuous monitoring -Continuous infusions -Tracheostomy decannulation	577 mImCU patients from ED (55 %), ICU or medical wards	-In ImCU time of stay 7 days -Direct discharge rate 14 % -ICU transfer 8 % -In ImCU mortality 14 %
Intermediate Medical Care Unit	// //	//		
Hager DN 2017 [51] USA	15 to 21 beds Adjacent to medical wards [university hospital]	-Continuous pulse oximetry -12-lead cardiac telemetry	177 ImCU patients from ED, ICU or wards and then transferred to ICU	Post quality improvement project: -Survivors in hospital LoS from 21 [10-37] to 12 [6-20]
Intermediate Care Unit	nurse:patients 1:3 Non-intensivists	Post quality improvement project: Charlson's index from 2.7 ± 2.1 to 2.8 ± 2.3 APACHE II from 24 ± 7 to 23 ± 6 SAPS II from 37 ± 17 to 34 ± 15		-Deaths in hospital LoS from 13.5 [8–20.5] to 25 [13-27] -ICU transfer from 13 % to 10 % -In hospital mortality from 34 % to 21 %
Simpson CE 2017 [48] USA	15 to 18 beds Adjacent to medical wards [academic medical centre]	-Continuous pulse oximetry and cardiac monitoring -Arterial/venous pressure -NIV -Vasopressors -Antiarrhythmic drugs -Bedside intermittent hemodialysis	317 mImCU patients from ED	-In ImCU time of stay 2.4 [1.7–3.7] days -In hospital LoS 4 [3-8] days -DNR (of non-survivors) 14.3 % -ICU transfers 13 % -In hospital mortality 4.4 %
Medical Intermediate Care Unit	Nurse:patients 1:3 Non-intensivists	Charlson's index 2.7 ± 2.3 APACHE II 15.6 ± 6.5 SAPS II 20.7 ± 11.8		
Hager DN 2018 [50] USA	18 beds Adjacent to general medical unit [academic medical centre]	-Continuous pulse oximetry and cardiac monitoring -NIV	628 ImCU patients from ED (50.8 %), ICU (7.2 %) other wards or other hospitals (3.7 % surgical patients)	-In ImCU time of stay 2.2 [1.3–3.8] days -In hospital LoS 6.9 [3-14] days -Direct discharge rate 14.8 % -DNR 5.7 %
Intermediate Care Unit	nurse:patients 1:3 Internal Medicine and subspecialty physicians	Charlson's index 2 [1-4] ImCUSS 10 [0–16]		-ICU transfers 16.4 % -In ImCU mortality 2.1 % -In hospital mortality 8.3 %
Morland M 2018 [57] Norway	10 beds // [university hospital]	-NIV -Vasoactive drugs -Electrolytes infusions -Intermittent dialysis	1118 ImCU patients from ED or Internal Medicine ward	-In ImCU time of stay 1.7 days -In hospital LoS 9.4 days -DNR/DNI 26 % -ICU transfer 5.6 %
Medical Intermediate Care Unit	// Intensivists and Internal Medicine physicians	Charlson's index ≥ 2 48 % SAPS II 34		-In hospital mortality 13 % -1-year-mortality 27 %
Innocenti F 2019 [75] Italy	two Emergency Department HDUs // [1300 and 800 beds respectively]	-Monitoring -NIV -Central venous catheter or arterial line -Vasoactive drugs -Renal replacement therapy	3311 HDU patients from ED (100 % in the first ED-HDU, 56 % in the second), ICU (2 %) or medical wards	-Direct discharge rate 25 % -ICU transfer 6 % -In HDU mortality 5 % -In hospital mortality 13 %
High-dependency Unit	// Emergency physicians	Charlson's index 2.9 ± 2.6 SAPS II 34 ± 17 SOFA 3.8 ± 3.3		
Molmy P 2019 [76] France	12 beds Separated from ICU [500 beds acute general hospital]	-NIV -Vasopressors -Palliative sedation	404 ImCu patients from ED (35.6 %), ICU (17.1 %) or wards (35.9 % surgical patients)	-In ImCU time of stay 4 [2-6] days -In hospital LoS 12 [8-22] days -Limitations of life supporting care 19.5 % -In ImCU mortality 7.4 % -In hospital mortality 15.3 %

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Table 1 (*continued*)

First Author Pub. year [ref] Country Unit name	ImCu Settings: n° beds Location [hospital data] Staff: nurse:patients Physicians' specialty	Reported Clinical Activities Scores	ImCU Population [Overall study's sample Size, if larger]	Reported Outcomes
Intermediate Care Unit	nurse:patients 1:3 Intensivists and Emergency physicians	Charlson's index 5 [2-6] SAPS II 24 [15-32] SOFA 2 [1-4]		
Brusca RM 2020 [49] USA	18 beds Adjacent to general medical units [academic medical centre]	-Continuous pulse oximetry -Cardiac telemetry -NIV	628 ImCU patients from ED (50.8 %), ICU (7.2 %), medical wards or other hospitals (3.7 % surgical patients)	-In ImCU time of stay 2.2 [1.3–3.8 days] -In hospital LoS 6.9 [3-14] days -DNR/DNI 5.7 % -In ImCU mortality 2.1 %
Intermediate Care Unit	nurse:patients 1:3 //	Charlson's index 2 [1-4] MPM_0III 6 [3-12] % APACHE II 15 [12-21] SAPS II 21 [13-30] SAPS 3 46 [39-55]		-In hospital mortality 8.3 %
D'Andrea A 2020 [77] Switzerland	4 beds Integrated in a dedicated centre for elderly patients [1800 bed tertiary care institution]	-Monitoring of vital signs	345 ImCU Patients ≥ 75 years	-In ImCU time of stay 4.5 days -1-year mortality 43 %
Geriatric Intermediate Care Unit	// //	Functional Independence Measure 66 ± 26		
Morland M 2021 [58] Norway	10 beds // [university hospital]	-NIV -Vasoactive drugs	2170 ImCU patients from ED or Internal Medicine ward	-In ImCU time of stay 1.6 days -In hospital LoS 9.9 days -In ImCU mortality 7 %
Medical Intermediate Care Unit	// Intensivists and Internal Medicine physicians	Charlson's index ≥ 2 43.9 % SAPS II 34		-3-years mortality 41.7 %
Kistler EA 2023 [78] USA	3–6 beds Integrated in general wards [673 beds tertiary care academic medical centre]	-NIV -Invasive ventilation via tracheostomy with stable settings -Continuous infusions -Postoperative monitoring	230 ImCU patients from ED (10.9 %), ICU (42.3 %) and general wards (38.7 % surgical patients)	-In ImCU time of stay 2 [1-4] days -In hospital LoS 11 [5-28] -ICU transfer 16 % -In ImCU mortality 10 % -ImCU generated substantial ICU bed capacity
Intermediate Care Unit	nurse:patients 1:3–4 Hospitalists and Surgeons supported by Intensivists consultations	//		
Leibner G 2023 [33] Israel	5 beds Integrated in 4 internal medicine departments (tot 20 beds) [806 beds tertiary care medical centre]	-Central monitor system -NIV -Invasive ventilation -Vasopressors	1627 ImCU patients [56,002 in general beds and ICUs]	-Intensive Medical Treatments are predominantly delivered in unmonitored settings -ImCU patients were older, had longer hospitalization (21.3 vs 14.5 days), mortality (22 % vs 12 %) and receive most of the IMT compared to ICU patients (for example vasopressors 9.7 % vs 5.5 %)
Intermediate Care Unit	nurse:patients 1:5 Internal Medicine physicians	Elixhauser comorbid conditions ≥2 78 %		
Njoki C 2024 [79] Kenya	3 HDUs: 3, 9 and 16 beds // //	-HFNC and NIV -Invasive ventilation -Vasoactive and sedative drugs -Renal replacement therapy -Emergency surgery	2445 HDU patients from Kenya critical care multicentre registry admitted from ED (62 %), ICU (7.5 %) or wards (9.2 % surgical patients)	-In HDU time of stay 2 [1-4] days (3 [1-6] in ICU) -In HDU mortality 6.5 % (30.5 % in ICU) -HDU patients were older and with more comorbidities than ICU ones
High-dependency Unit	nurse:patients 1:2 Intensivists in two HDUs and Internal Medicine physicians in one HDU	APACHE II 6 [3-9]	[1447 ICU patients]	
Porta G 2024 [80] Italy	12 HDUs: 8.8 ± 4.9 beds // //	-Ultrasounds -NIV -Vasoactive drugs -Central venous line -Haemodialysis	3670 HDU patients from Multicentre HDUs belonging to Emergency Departments, admitted from ED (81 %), ICU (6.7 %) or wards (6.6 % surgical patients)	-In HDU time of stay 5.3 ± 5.8 days -Direct discharge rate 31.2 % -ICU transfers 7.4 % -In HDU mortality 8.4 % -In hospital mortality 16.6 %
High-dependency Care Unit	nurse:patients 1:4 ± 1 Internal Medicine or Emergency physicians	BRASS index > 19 12 %		-Remarkable variability between HDU structures and populations is critical for the assessment of the quality of care

ImCU (Intermediate Care Unit); HDU (High-dependency Unit); SICU (Subintensive Care Unit); PCU (Progressive Care Unit); ICU (Intensive Care Unit); LoS (Length of Stay); NIV (Non-invasive ventilazion); HFNC (High-flow Nasal Cannula); APACHE (Acute Physiologic Assessment and Chronic Health Evaluation); SOFA (Sequential Organ Failure Assessment); SAPS (Simplified Acute Physiology Score); ImCUSS (Intermediate Care Unit Severity Score); MPM (Mortality Probability Model), ICNARC (Intensive Care National Audit & research Centre); MMSE (Mini Mental State Examination); TISS-28 (Therapeutic intervention scoring system); NEMS (Nine Equivalent of Manpower Score); NAS (Nursing Activities Score); BRASS (Blaylock Risk Assessment Screening Score).

3.3. Staffing

The nurse-to-patient ratio was shown in 22 (64.7 %) articles and varied from 1:2 to 1:6, with a median ratio = 1:3.1, without significant difference between European and USA studies.

With the limitation of the relatively small number of studies that presented both data, in the stand-alone and adjacent to wards ImCUs the median ratio was 1:3 while in the integrated in wards ImCUs nurse-to-patient ratio was lower (1:3.75).

Eight studies reported indications about nurses' training: Franklin et. al in 1988 made explicit that nurses had to be certificated in Advances Cardiac Life Support (ACLS) and trained for arrhythmia detection, while in the other seven studies [33,48,50,66,68,71,78] there were references to training in using technical equipment or participating to Intensive Care diplomas or to ImCU orientation programs.

Details about medical staff were missing in 12 articles: intensivists alone were involved in 7 experiences, and mixed intensive care and non-intensive care physicians in 3 cases.

Hospitalists-led units, comanaged with surgeons or other specialty physicians, were found in 2 realities and at least 10 ImCUs were managed by internists (with or not emergency medicine or other sub-specialty physicians as geriatricians). The ratio between ImCUs where intensivists were primarily involved (even in co-management) versus exclusively non-intensivists led ImCUs was approximately 50:50.

Two of the included studies showed data about the physician-to patient ratio, amounting to 1:6 [76] and 1:10 [80]; one study mentioned an attending physician-to-patients ratio half than an ICU [64].

3.4. Patients

All were ImCU populations, and only four articles did not detail patient-inflow. A step-up role admitting patients from standard wards was shown in 28 (82.3 %) articles and a step-down role from ICUs in 23 (67.6 %), the same number of studies (23, 67.6 %), but not the same studies, declared both step-up and step-down admissions, while 28 (82.3 %) reported direct admissions from ED. Patients admitted in ImCUs from ED ranged from 10.8 to 100 %, median 50.8 % [IQR 26.2–71], while those ones admitted from ICUs ranged from 1 to 60.8 %, median 10.7 % [IQR 6.6–25.8].

19 of the 34 studies selected to be focused on medical ImCUs reported the treatment of surgical patients, widely varying from 4 to 40.7 % of all patients, median 13.3 % [IQR 8.5–36.4].

Admission of surgical patients and admissions from ED were substantially similar between European and USA studies: 13.0 % [6.6–35.9] vs 16.8 % [13.1–37.8] and 45.3 % [19.7–59.7] vs 37.6 % [25.9–44.6], respectively. The step-down role, instead, appeared less frequent in European ImCUs with an admission from ICU rate of 6.7 % [2–17.1] vs 41.7 % [16.6–42.3] in USA ones.

3.5. Activities

At least one of the possible clinical activities provided was reported in 30 of the 34 analysed studies.

Continuous vital signs or EKG monitoring and non-invasive ventilation were described as the two distinctive and characterising ImCU actions and multiple and complex IV infusions (as amines, vasopressors, antiarrhythmics, electrolytes or blood components) appeared as the third requirement.

However, the other reported services, as peripheral arterial or central venous line, hemofiltration or haemodialysis, cardioversion and pacing, were different and non-standardised, primarily due to specific combination of ImCU location, staff competences, and other-than-ImCU in-hospital services (almost never defined in these studies).

Limitations of supportive care were not systematically explained but included first and foremost mechanical ventilation, followed by advanced invasive monitoring and more-than-one vasoactive drug.

3.6. Scoring systems

Among the 34 articles only 5 did not refer to any score. The more frequently reported indicators of clinical severity were the Simplified Acute Physiology Score II (SAPS II) in 15 articles, ranging from 20.7 to 38.2 points, median 34 [IQR 22.3–34.7], the Acute Physiologic Assessment and Chronic Health Evaluation II (APACHE II) in 13 articles, ranging from 6 to 24 points, median 14.9 [IQR 12.4–18.2], and the Sequential Organ Failure Assessment (SOFA) in 5 articles, ranging from 2 to 7.2 points, median 4.5 [IQR 3.8–5.5]. The Intermediate Care Unit Severity Score (ImCUSS), instead, the only severity-of-illness system specifically designed and calibrated for ImCUs, showed contrasting results in the first derivation (21.9 ± 16.1) [53] and in the external validation cohort (10 [0–16]) [50].

Moreover, ICU-native prognostic models as the Mortality Probability Model II and III (MPM_0II and III) and the Intensive Care National Audit & Research Centre (ICNARC) predicting risk of hospital death were randomly found, with values of 14.7, 8.6 and 12 %, respectively.

Patients' clinical complexity was additionally explored evaluating comorbidity and performance status, by the Elixhauser Comorbid Condition and the Charlson's Comorbidity Index (CCI), the more widely cited, ranging from 1.5 to 7.4 points (median 2.7 [IQR 2.1–5]), the Mini-Mental State Examination (MMSE), the Blaylock Risk Assessment Screening Score (BRASS), and the pre-admission Barthel Index, ranging from 28.8 to 95.2 points, median 86.2 [IQR 78.1–91.2].

Finally, the nursing workload was quantified by the Nine Equivalent of Manpower Score (NEMS), the Nursing Activities Score (NAS), and the Therapeutic Intervention Scoring System 28 (TISS-28), the last with a median value of 18.7 [IQR 6.6–20.5].

3.7. Outcomes

At least one outcome of interest is described as objective in all studies included. The in-ImCU time of stay, examined in 24 (70.6 %) cases, was between 0.4 and 11.3 days, median 3.7 [IQR 2.2–6.8], while the overall in-hospital LoS, examined in 16 cases, was between 4 and 26.6 days, median 12 [IQR 8.9–18.2].

In 9 (26.5 %) articles the direct discharge rate was evaluated, presenting a very wide range: 0.2–41 %, median 18.9 % [IQR 10.2–26.5].

The do-not-resuscitate or do-not-intubate (DNR/DNI) orders were declared only in 8 (23.5 %) studies and concerned from 5.7 to 26 % of patients, median 12.3 % [IQR 8.7–19.6]. However, no relations can be drawn with scores of illness severity nor comparison with outcomes as mortality or ImCU time of stay, i.e studies reporting a higher DNR rate do not necessarily have a higher mortality.

The two main clinical outcomes were ICU transfers and mortality: ICU transfers were reported in 19 (55.9 %) articles, with a lower rate of 0 %, a higher one of 1 6.4 % and a median of 8 % [IQR 5.6–12.3]; the in-ImCU mortality was declared in 21 (61.8 %) studies, varying from 1.1 % to 14.0 % (median 6.2 % [IQR 3.6–8.3]), while the in-hospital mortality, declared in 27 (79.4 %) studies, varied from 3.1 % to 34 % (median 14 % [IQR 8.7–19.1]). ICU transfers rate was higher in European studies: 7.4 % [5.6–8.5] vs 5.8 % [3.3–9.8] in USA ones. A contrary trend there was in mortality: the in ImCU mortality was 5.1 % [3.7–7.8] in Europe vs 6.5 % [2.7–9.6] in USA, while the in-hospital mortality seemed higher in Europe 1 3.5 % [11.4–15.6] vs USA 8.7 % [7.0–9.8].

4. Discussion

Data extracted from the 34 studies analysed confirm the variability in general medical ImCU structures, processes and outcomes; the general medical ImCUs admitted acute high care and complex patients, as evident when comparing the pooled median values of severity and co-morbidity scores (SAPS II = 34 [22.3–34.7], SOFA = 4.5 [3.8–5.5] and

CCI = 2.7 [2.1–5]) with analogous evaluations in ICU patients [81], but unlikely to be adjusted for designs, staffing and patient inflow or related to outcomes due to studies' heterogeneity.

Over the past years, the analysis of critical care services has not shown standard definition [82], likewise for medical ImCU formats many differences have been found, what may constitute an ICU bed in one country may be considered an ImCU bed in another and inequalities may be expected among regions or institutes in the same country. These premises make difficult to draw conclusions about the more appropriate and cost/effective model but direct towards a shareable mission of appropriateness for medical high care patients, often admitted in Internal Medicine units despite higher level of care required.

Reasons to endorse ImCUs as implemented areas to rationalize ICU beds have been so far recognised primarily on benefits for ICUs themselves [10,83–87] (earlier discharges, lower risk of premature discharges to standard wards [88,89], possible lower costs by providing care in areas with a lower nurse-to-patient ratio and less expensive technology [65,90]), and retrospective analyses on ICU-bed utilization have reported a large proportion, between 25 and 45 %, of low risk patients that could be safely cared for in intermediate care settings [91–97].

Nevertheless, ImCUs should be assessed not only in saving ICU beds but also in reducing inappropriate bed use by critical patients in standard wards [98–100].

The general medical ImCU strategic aim, indeed, is being increasingly identified in ensuring an adequate setting for patients needing high but non-intensive care, highlighting the crucial role of in-hospital organizational pathways customized to optimize available technological and human resources.

Over the years integrated/adjacent to ICUs and integrated/adjacent to wards general medical ImCUs were represented in substantially equal parts. However, a time trend can be evinced that distances general medical ImCUs logistically from ICUs and manageably from intensivists [101], with effective hospitalists- or internists-led models reported in the more recent experiences, as these professionals may assume leadership in co-managing (with other specialists) acute complex patients.

Since the ideal staffing should depend on the acuity and the case mix of patients [11], to date there is no evidence to correlate intensivists, specialists or internists management nor ImCU location with clinical outcomes: the question goes back to resources and competencies.

The relative high rates of in-ImCU mortality 6.2 % [3.6–8.3] and in-hospital mortality 14 % [8.7–19.1] would rather seem to be attributable to the clinical severity revealed by the reported scores. However, the scoring systems given in selected studies, excluding ImCUSS just showing limitations in its first validation cohort, were not specifically set for ImCU populations, especially SAPS II, APACHE II and SOFA for illness severity, and TISS-28 for nursing workload [102], reducing effectiveness in prognostication, but remaining useful to objectify clinical status and to compare data.

The poor outcomes observed in these patients with acute organ failures and comorbidities raise more questions about the appropriateness of care [58,76,78], intended as the adequacy of resource utilization.

The variability in admissions from ED, surgical and step-up/step down rates enhances general medical ImCUs as facilities that should meet the requirements for appropriate care in hospitalized high care patients and focusing on ImCUs as a PPC deployment, a clinical problem-oriented and patient-centred approach can't be neglected.

The identification of prognostic factors is reasonable to select patients that would benefit from admission [56] but also from in-ImCU time of stay, allowing to plan patients-tailored in-hospital trajectories.

In selected studies the in-ImCU time of stay was 3.7 days, a reasonable median time to obtain clinical stabilization, but varied from 0.4 to 11.3; this wide range and the differences in patient flow, especially percentages of patients admitted from and transferred to ICUs, should be considered with the evaluation of the hospital governance where an ImCU is located and not only of the ImCU per se.

A quality assessment should be tailored on the pro-active general medical ImCU role as a "service" performing to intercept and secure the appropriate setting for patients not directly requiring ICU.

Key indicators should therefore be considered at the ImCU itself, at the ICU, and at the hospital level, ideally warranting a hospital-outcome-based approach and not focusing only on patient-based outcomes [47], because ImCUs cannot be regarded as a separate entity, but deeply embedded in the critical care in-hospital chain. To avoid misinterpretation, partly due to the intrinsic nature of "transition units", ImCU effectiveness should not be considered in comparison with ICUs or general wards, but as a micro-system integrated in the overall hospital macro-organization.

All these remarks rekindle the strict need of ImCU inflow and outflow criteria to manage patient flow and a methodological effort is needed to trace sustainable models that match the general medical ImCU mission.

By quoting ImCU identity from results of i) settings, ii) processes and iii) outcomes, the second step results the more distinctive. Activities as continuous monitoring, non-invasive ventilation and multiple advanced infusion therapies (i.e vasopressors) were the more constant topics and, to ensure these high care treatments, a nurse-to-patient ratio higher than in standard medical wards is required, recognising the median result > 1:4 as a characterising and indispensable ImCU element [15].

A functional proposal derived from this evidence may consist in defining inflow and outflow criteria not on illness severity (*disease-based*) but on the activities (*activity-based*) provided by each general medical ImCU.

The appropriateness criteria would be based on the patients' needs, for both treatments (i.e. activities) and requesting assistance (i.e. nurse-to-patient), following PPC principles [Fig. 2].

As the *right setting* for the *right patient* could be thus defined, the systematic detection of Early Warning Scores (EWS) in standard wards (as Internal Medicine ones) could guarantee the *right time* tracking the early detection of deteriorating patients potentially transferable to ImCUs as suggested by experiences based on intensity of care [103,104].

Beyond this, as severity, comorbidity and pre-admission performance scores could support clinical judgement in decision making to guarantee the prompt access (ideally triggered by EWS) to ImCU treatments or monitoring, a consequent time of 72–96 hours could be reasonable to overcome clinical instability and to plan the next adequate setting with bed management systems, enhancing in-hospital patient flow.

With the advent of electronic medical records new possibilities are emerging for data driven policies and effective benchmarking using past data to inform future behaviours, [105–107], wishing for ImCUs as "flexible servers" [108] with design, bed-number, staff and workflow tailored on each hospital requirements.

As attended, the main limitation of this study consists in the heterogeneity of published experiences from a wide timeframe. Data were therefore incomplete, with likely risk of publication biases in favour of positive effects or of incomplete representative samples, making comparisons difficult due to differences in designs and objectives.

Future multicentre well-designed studies are the unavoidable step to plan resources' investments, derived from the punctual snapshot of healthcare models, substantiated by evidence-based policies and resulting from the integration of research evidence, clinical realities and patient values.

5. Conclusions

Despite the wide variability of formats and designs, general medical ImCUs are being increasingly recognised as the appropriate setting for acute medical patients needing non-intensive high care treatments, with adequate nursing staff and possible pivotal role of internists in co-management.

Activity-based admission criteria tailored on specific hospital resources and governance could be a process model to set ImCU patient

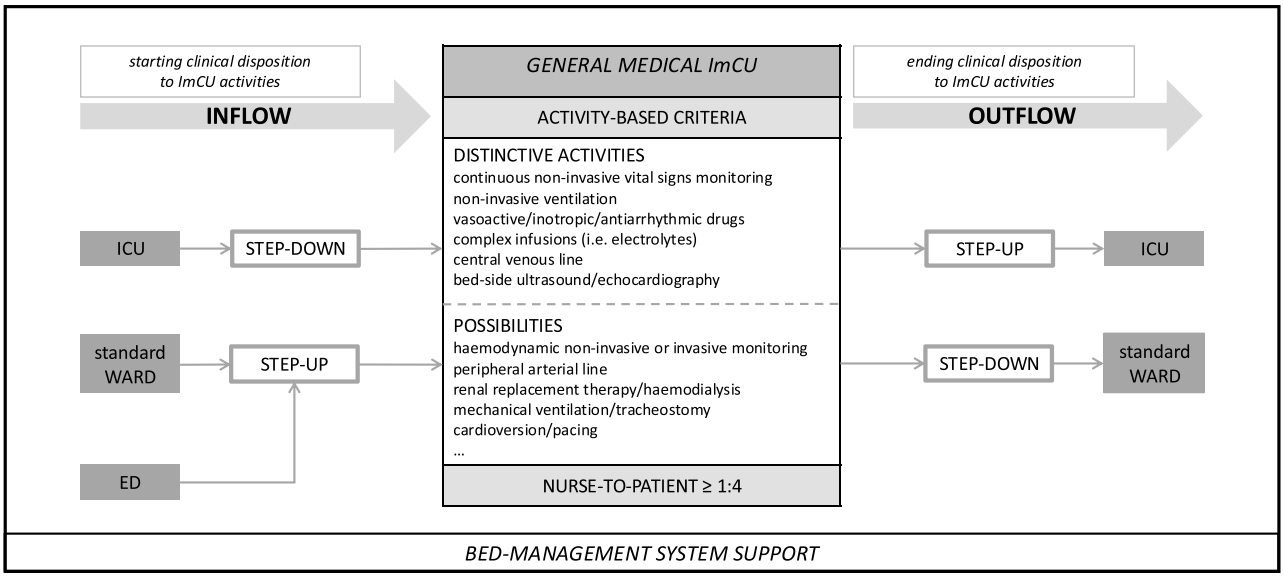

Fig. 2. A proposal patient flow framework for general medical Intermediate Care Units.

flow inferred from a Progressive Patient Care-based approach.

Adequate quality of care key indicators should be drafted considering the functional role of general medical ImCUs in hospital macrosystems.

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Supplementary materials

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