	Author & Year of pubblication	Country	Aim	Design	Study setting	Data Source	Nr of patients & Year of data collection	Intervention	Type of outcome	Outcome	Limitation	Conclusion
1	Easter et al. 2019	Colorado, USA	to evaluate 9 different models on ED flow and patient-centered metrics	Quantitative, exploratory, causal study that adopted a DES based experimental analytic research	Urban, academic, tertiary care facility and a primary teaching hospital with approximately 101,000 patients per year	EMR	Model 1:5,161 Model 2: 7,108 Model 3: 4,296 Model 4: 5,996 Model 5: 8,357 Model 6: 5,043 Model 7: 7,040 Model 8: 8,427 Model 9: 5,328, Year 2013-2016	9 flow design models based on the interaction of 3 flow models (ESI, intake attending physician, and no split flow) and 3 physical design typologies (zero, one, and two internal-waiting areas)	-length of stay (min) -bed utilization rate (pt/bed/day) -door to provider (min) - LWBS (%) - movements per patient (n)	Mean (±SD) -Model 1: 268.6 (±130.1) Model 2: 209.6 (±115.5) Model 3: 338.5 (±168.4) Model 4: 229.2 (±129.2) Model 5: 183.3 (±114.3) Model 6: 303.2 (±161.3) Model 7: 211.4 (±127.8) Model 8: 175.2 (±113.1) Model 9: 274.9 (±156.8) -Model 1: 3.15 (± 0.95) Model 2: 4.40 (± 0.90) Model 3: 2.43 (± 0.57) Model 4: 3.54 (± 1.00) Model 5: 4.97 (± 0.90) Model 6: 2.91 (± 0.60)	-Single center analysis -3 different time periods for empiric data -Exclusion of boarding time excluded from the LOS - Restriction of internal-waiting area	DES model combining flow split by an intake-attending physician and multiple internal-waiting areas resulted in improved ED operational and patient centered metrics

										Model 7: 4.30 (± 1.00) Model 8: 5.02 ± (1.02) Model 9: 3.30 (± 0.61) -Model 1: 31.8 (± 23.6) Model 2: 13.9 (± 7.4) Model 3: 53.8 (± 29.3) Model 4: 26.3 (± 22.1) Model 5: 9.8 (± 6.9) Model 6: 44.7 (± 27.5) Model 7: 23.7 (± 19.6) Model 8: 9.6 (± 6.8) Model 9: 39.9 (± 26) -Model 1: 4.32 (± 1.16) Model 2: 2.50 (± 0.93) Model 3: 6.24 (± 2.02) Model 4: 3.17 (± 0.73) Model 5: 1.60 (± 0.41) Model 6: 4.58 (± 1.47) Model 7: 2.51 (± 0.52) Model 8: 1.17 (± 0.31) Model 9: 4.01 (± 1.23)		

										-Model 1: 3.2 (± 1.5) Model 2: 3.4 (± 1.6) Model 3: 1.7 (± 0.6) Model 4: 4.0 (± 1.8) Model 5: 4.1 (± 1.8) Model 6: 1.9 (± 0.7) Model 7: 4.2 (± 1.8) Model 8: 4.2 (± 1.8) Model 9: 2 (± 0.7)		
2	Woodward et al. 2019	Australia	to describes the impact of a new model of care and to present a comparison of several metrics of ED performance and patient flow	Retrospective study	Public facility hospital with 119 inpatient beds and approximately 35 000 ED patients per year	Information and databases system	2,660 (Year 2014) 5,078 (Year 2015), 1 January - 30 September (9 month periods, before and after the introduction of CDU)	CDU model	-access block (%) -NEAT (%) -ambulance ramping (n) -level three escalations (n)	Before vs after the opening of CDU -43.3% vs 26.7% -69.0% vs 70.1% -2027 vs 1239 -21 vs 5	-Retrospective and single center study -Admission and discharge times: possible confounders	CDU model resulted in significantly improved performance on a range of KPIs
3	De Anda et al. 2018	Texas, US	to present a quality improvement initiative	Modeling approach analysis	Urban hospital research department with 30,233 admission per week	TeleTracking database (included all patients admitted from the ED)	NR, 2016	Quality improvement initiative with a flow nurse coordinator	-time to transport an admitted patient from the ED to an inpatient bed (min)	Without vs with flow -104 vs 84	NR	The quality improvement initiative created an innovative method of improving patient throughput in the ED and

												increasing staff satisfaction
4	Garrett et al. 2018	US	to identify efficient processes to optimize flow of patients through the ED	Prospective pre/post-interventional cohort study (all ITT patients presenting to the ED during study period)	Tertiary care (level 1 trauma center) with 74 bed	Administrative database	222,713 patient/visits (107,217 and 114,833 12 months pre and post intervention respectively), 2-year period	Vertical split-flow model	-Door to provider (min) -provider to disposition (min) -disposition to discharge (min) -total ED LOS (min) -likelihood to recommend -physician overall patient satisfaction score -nurse overall patient satisfaction score	Pre vs post intervention Median -34 vs 36 -140 vs 128 -25 vs 25 -250 vs 233 Mean -83.9 vs 86. -86.7 vs 87.4 -85.3 vs 86.6	-Lack of randomization and unmeasured confounders -Ongoing initiatives in the facility -No recorded disaster activations or known events during the study period -Possible drift in the manner in which ESI acuity levels assigned during the study period -Additional staffing added to the ED during the study period: possible confounder -No physician, advance practice providers, nurse or technicians added to the departmental plan, during the study period	Initiation of a vertical split flow model was associated with improved ED efficiency

5	Improta et al. 2018	Campania, Italy	to improve the management of patients in the ED, focusing on increase the flow to the client/patient	Qualitative, quantitative and simulation analyses	Hospital with level II ED with approximately 94,000 patients per year	Historical and post-Lean access records	Pre-Lean: 16,563 Post-Lean: 17,147, January 2015 - June 2015 and April 2016 - June 2016	Lean thinking	-Patients with a yellow code examined within 30 min (%) -patients with a green code examined within 1 h (%) -patients with a green code not ~~sent to~~ hospitalized~~ation~~ with a stay time ≤ 4 h (%) -patients sent to hospitalization with a stay time ≤ 8 h (%) -lead time for red code (min) -lead Time for yellow code (min) -lead Time for green code (min) -lead Time for white code (min)	Pre vs post-lean: -53.6 vs 56.9 -52.6 vs 54.3 -94.8 vs 96.8 -99.8 vs 99.8 Mean (±SD) -72 (±36) vs 71 (±30) -151 (±100) vs 147 (±67) -164 (±116) vs 163 (±120) -160 (±173) vs -158 (±156) Mean (SD) - 00:22:54 (00:28:25) vs 00:21:24 (00:26:55) -01:47:55 (01:14:44) vs 01:41:55 (01:14:44) -02:31:02 (01:27:18) vs 02:19:12 (01:03:20) -04:18:57 (01:52:11) vs 04:01:07 (01:02:57)	NR	Lean Thinking application increases the efficiency of services, reduces waste in terms of waiting times and improves the quality of the working environment for operators, increases the performance of the ED (% of hospitalized patients according to triage codes and waiting times)

									-waiting time I – II triage (min) -waiting time I triage – taken into care (min) -waiting time taken into care – dismissal (min) -waiting time I triage – dismissal (min)			
6	Khanna et al. 2018	Adelaide, Australia	to identify optimal inpatient discharge time targets to support acute patient flow	Retrospective observational study with modelling process	Quaternary teaching hospital with approximately 70,000 annual ED	Hospital's electronic medical record with simulation software	~50,000, October 2011-December 2012	Early 7 different discharge scenarios (based on different % of discharged patients)	-NEAT performance (%) -bed occupancy (%) -inpatient LOS (%) -wait for inpatient bed – patients from ED (%) -wait for inpatient bed – all patients (%)	Change post vs baseline: Best scenario (4: 80% of patients to be discharged by 11 a.m.)/ Worst scenario (2: 35% of patients to be discharged by 11 a.m., 70% by 2 p.m. and 100% by 5 p.m.) -+16.2%/-5.7% --1.5%/-0.2%	-Single center and 15 months study - Performance metrics focused on a patient's immediate hospitalization -Lack of data on potential readmission - Modelling based on current administrative data -Patient flow changes based on	Optimizing discharge timing has the potential to deliver significant improvements to patient flow, bottle neck and alleviate overcrowding

									-bed days (%) -number of patients (%)	--1.6%/-0.3% --24.9%/-6.0% --23.5%/-5.7% --0.7%/-0.1% -+0.9%/+0.2%	simulations only	
7	McHugh et al. 2018	US	to focus on the impact on LOS of the ED Telehealth Express Care Service and provide a brief discussion of the application -facilitated virtual emergency -care service	Observational analysis	City hospital with > 95,000 ED visits per year (pediatric and psychiatric ED)	ED greeted and triaged patients	> 1,850 patients, July 2016 - October 2017	ED Telehealth Express Care Service	-LOS (hours) -patient-satisfaction score	Pre vs post intervention: -2.5 vs 38 minutes -91.3 vs 84.6	-Need for more rigorous investigation to determine the impact of the ED Telehealth	ED Telehealth has the potential to ease the stress of an overburdened health care system, enhance flow by expediting the care of lower-acuity patients and freeing up ED staff to attend to the critical, time-sensitive needs of sicker patients
8	Ngo et al. 2018	Australia	to assess the impact of the WA FHR program on multiple	A state population-based intervention study	4 tertiary and 1 general hospitals with approximat	Administrative health databases via record linkage and interrupted	3,214,802 ED presentation records (1,203,513 patients),	FHR program	-Access Block (%) - ED occupancy rate (%)	Pre-FHR Trend/FHR Change in Level/FHR Change in Trend (min	-Extensive range of ten outcome measures related to ED	WA FHR had a consistent effect on `flow' measures:

			measures of ED functioning and patient outcomes for 5 participating hospitals		ely 109,678 ED patients per year	time series analysis	January 2002 – December 2013		- ED attendances (%) -ED re-attendance (within 7 days of index ED discharge) (%) -EDLOS (hours)	and max among 5 hospitals) Mean -Hospital E: 1.017/0.989 /0.939 and Hospital C: 1.035/0.694/ 0.868 -Hospital C: 1.20% /0.23%/- 0.80% and Hospital E: 1.95%/- 0.95%/- 6.23% -Hospital C: 6.62%/36.03 %/-5.57% and Hospital A: 0.18%/- 8.78%/8.27% -Hospital A: 0.00%/0.04% /0.01% and Hospital E: 0.13%/- 0.14%/- 0.14% Median -Hospital E: 0.022/0.266/ 0.029 and Hospital A: 0.028/- 0.559/-0.085	-Exclusion of factors such as patient age, comorbidity, mode of transport, socioeconomic disadvantage, system, environmental, seasonal factors and their interplay with the intervention effect -Limited generalizability	significantly reducing ED overcrowding and access block and enhancing ED efficiency
9	Potts et al. 2018	US	to implement an eSBAR	Observational project	Chicago, urban academic	Tool within the EMR designed by	NR, 10 month after the	Standardized Electronic Nursing	-ED RTM ~~Clean~~-to-	Before vs 3 weeks and 10 months after	NR	Implementing a standardize

			nursing hand off process nursing handoff process to decrease boarding time as measured by the RTM-to-occupied metric in the CMT	improvement initiative	medical center with 495-bed	the EMR vendor	implementation	Handoff Process	occupied time (min)	implementation Mean -84 vs 49 vs 47		d electronic handoff process can result in decreased ED crowding through a decrease in boarding time
10	Prang et al. 2018	Victoria, Australia	to evaluate the impact of the national healthcare reforms on ED time-based process outcomes	Quasi-experimental study	34 public hospitals with a designated 24-hour ED	Victorian Emergency Minimum Dataset (34 hospitals)	13,241,509 ED presentations (27.30%, in 6 major hospitals, 43.70% in 14 large hospitals, 23.59% in 9 medium hospitals, and 5.40% in 5 small hospitals), year 2006-2016	Government national healthcare reforms	-Waiting time to treatment (min) -treatment within recommended time (%) -departing ED within 4 hours of arrival (%)	Pre vs post ED targets Major/Large/Medium/Small hospitals Mean (±SD) -41.82 (±58.47) vs 35.18 (±45.79)/40.54 (±55.42) vs 36.64 (±49.31)/46.61 (±55.89) vs 41.36 (±54.23)/34.89 (±44.40) vs 32.69 (±41.51) -70.03%vs 73.22%/74.01% vs 74.24%/71.36% vs 73.27%/83.24% vs 83.35%	-Inclusion of confounding influences -No comparator group	Australian national healthcare reforms have encouraged improved ED patient waiting times, treatment within recommended time, and departure within 4 hours of arrival. However, the reforms were not able to stimulate attainment of the recommended Australian

										-52.20% vs 61.24%/60.19% vs 62.57%/71.95% vs 70.64%/85.38% vs 80.87%		national targets
11	Zheng et al. 2018	China	to measure the relative efficiencies of Chinese public hospitals	DEA multiple-input multiple-output non-parametric evaluation	84 public hospitals with > 30 out-patient and ED patients and visit, per year 2010-2016	Chongqing Statistical database	> 30 patients per year, year 2010 - 2017	Four-Stage-DEA	-Technical efficiency -pure technical, efficiency -scale efficiency	Pre vs post adjustment: Mean (SD) -0.862 (0.135) vs 0.890 (0.115) -0.882 (0.017) vs 0.913 (0.089) -0.975 (0.048) vs 0.972 (0.055)	-Influence of results for the index selection - Impact on the input slack variables from the external factors -High sensitivity of the results for inputs and time analysis	The new medical reform plays a significant role in improving the efficiencies of public hospitals
12	Ramos et al. 2017	Portugal	to assess the effect of an implementation of a dedicated medical team in ED and to compare 2 organisational models of delivering emergency care in medical ED	Pre-post study	Tertiary academic hospital with approximately 150,000 ED visits, per year	Hospital data	153,718 patients (153,300 visits), year 2002 and 2005/2006	2 medical staffing model: -classic model (with 12-h shift in the ED) -dedicated model (with full-time EM physicians)	-Hospitalisation rate (%) -total time in the ED (hour) -readmission rate at 24 h (%) -ED mortality rate (%) -LWBS rate (%)	2002 vs 2005 vs 2006 -24.7% vs 19.1% vs 17.3% Mean -04:34:00 vs 05:48:34 vs 05:50:25 -1.1% vs 1.0% vs 1.3% -0.4% vs 0.6% vs 0.5%	-Year of data (2002-2006) -Generalizability of results for imputation of HR medical costs -Lacked data on the number of exams and prescribed medication	Implementing a dedicated team of doctors increased the medical productivity and reduced costs in the ED

									-Productivity (patients treated/hour) -Cost with ED's medical hour (€)	-0.9% vs 1.4% vs 4.5% -0.13 vs 0.20 vs 0.27 -6,544,622€ vs 4,695,463€ vs 3,602,738€		
13	Rathlev et al. 2017	Australia	to calculate and improve the weekly means of daily outcomes for the measures of efficiency and productivity in ED	Before and after study	Tertiary-care referral center ED with > 30,000 visits per year	Integrated information technology system Cerner FirstNet	109,135, December 2012 - December 2015	Redesign of the ED operational nursing leadership	-Patients seen per day (n) -LWBS (%)	Before vs after Mean -265 vs 299 -8.2% vs 4.5%	-No control group -Single center study	Measures of efficiency and productivity can be improved significantly with a dedicated operational nursing leadership structure
14	Claret et al. 2016	France	to investigate the impact of a new ED organization on patients' mortality and management delays	Retrospective, before-after study	Tertiary care hospital with 76,000 inpatient admissions and 317,000 ambulatory visits per year	Hospital's electronic medical record system	83,322, year 2011-2012	ED segmentation and staffing increase	-24-hours in-hospital mortality -30-days in-hospital mortality -in-hospital mortality -FMC (min) -emergency room LOS (hour)	Before winter 2011 vs before summer vs before winter 2012 vs after summer 2012 -0.4% vs 0.3% vs 0.4% vs 0.3% -1.6 % vs 1.4% vs 1.6% 1.2%	-Single-center and retrospective study -Low applicable of organizational and architectural criteria -Lack of control for patient volume between the study periods	The segmentation of our ED has led to changes in nurse staffing and ED structural layout, but was associated with a reduction in overcrowding

									-inpatient LOS (days) -triage delays (min)	-1.5% vs 1.5% vs 1.8 vs 1.3% Winter vs summer 2012 Mean (±) -129 (±133) vs 104 (±95) -7 (±7) vs 6 (±9) -9 (±15) vs 8 (±11) -7 (±33) vs 3 (±33)		
15	Li et al. 2016	Taiwan, China	to investigate the impact of EP seniority on clinical performanc e	Retrospective and 1-year cohort study	A tertiary referral medical center and 2 secondary regional hospitals with for > 300,000 cumulative mean visits per year	Administrativ e database	68,282, July 2011-June 2012	Seniority of EPs	-Door to-order time (min) -door-to-disposition time (hour) -discharge rate (%) -ED revisit in 72 h (hour) -mortality rate (%)	Urgent vs non urgent (EP with ≤ 5 years/6 - 10 years/> 10 years) Median - 10.2/10.7/12. 4 vs 9.4/9.5/11.3 -1.7/1.7/2.0 vs 1.5/1.5/1.7 - 33.4%/32.6% /32.4% vs 75.6%/74.8% /76.5% - 4.3%/4.5%/2. 9% vs 0.1%/ 0.1%/0.02% - 3.0%/1.9%/3.	-No available data regard to technical quality and the appropriaten ess of clinical care -Limited collection of confounding factors taken into consideration	The experience of senior EPs is associated with a lower ED mortality rate

										0% vs 5.5%/5.3%/5.1%		
16	Pierce et al. 2016	Ohio, USA	to evaluate the split flow model of care delivery and a provider in triage model, comparing 2 EDs	Qualitative and comparative analysis	2 community hospital EDs with approximately 44,700 and 43,000 patients, per year	EMR	68,603. (33,977 from experimental site and 34,626 from control site), year 2014	Split flow model (+/- PIT)	-DLOS (min)	Traditional versus split flow model vs split flow model + PIT: Median -173.8 vs 157.5 vs 145.3	- Confounding variables not controlled - Generalizability of the results to a larger population	Split flow model, with or without PIT reduces the DLOS
17	Wiler et al. 2016	Colorado, US	to evaluate the impact of a multifaceted innovative ED work-flow redesign on key operational measures	Retrospective, observational, pre-post intervention, comparison study	Large academic urban hospital (Level 2 Trauma Center with burn, stroke, myocardial infarction and palliative care center) with approximately 74,000 ED visits per year	EMS	17,307 (pre-implementation) 27,443 (post-implementation) 34,481 (1 year – post implementation), December 2012, July 2013 – December 2013	Front-end split flow model	-LOS (min) -door-to-physician time (min) -LWBS (%) -LBVC (%)	Pre vs post vs 1 year post implementation: Median -216 vs 170 vs 140 -54 vs 15 vs 12 -5.5% vs 0.5% vs 0.0% -0.8% vs 1.1% vs 0.6%	-Single-center study -No blinding of staff and physician -Only incident reporting system used as surrogate marker for patient safety -Patient complaints not included -Physician, staff satisfaction and patient experience not included	A front-end split flow model was cost-efficient and significantly improved ED throughput measures
18	Green et al. 2014	Australia	to determine whether there are real differences in ED performance between Australian	Cross-sectional analysis	Public hospitals with > 100,000 ED visits per year	National non-admitted patient ED care database	> 5.8 million ED visits, July 2009 - June 2010	Triage scale and jurisdictional differences in ED	-Waiting times (min)	ACT vs NSW vs NT vs Qld vs SA vs Tas vs Vic vs WA: Mean -65.7 vs 38.5 vs 56.4 vs 47.6 vs SA 43.0 vs 52.0	NR	Although the Council of Australian Governments has adopted raw measures for ED performan

			states and territories							vs 41.7 vs 45.6		ce, there are no consistent differences in ED waiting times between states and territories
19	Cheng et al. 2013	Toronto, Canada	to examine the impact and limitations of adding 6.5 hours of MDRNSTAT on ED patient flow and quality of care	Cluster, randomized-controlled trial over a 26-week period	Academic tertiary level hospital with approximately 45000-patient/visits per year	2 computerized information systems (EPR and EDIS)	3,163 (control group) 2,387 (EP) 750 (MDRNSTA) 3,137 (EP + MDRNSTAT): 3137, October, 2009 - April, 2010	MDRNSTAT (+/-EP)	-CTAS 2-3, EDLOS for discharged (hour) -CTAS 4-5, EDLOS for discharged (hour) -LWBS (%) -Mortality (%) -BW request Time (hour) -DI Request Time (hour) -Consult Request Time (hour)	Non consulted and consulted (control vs EP vs MDRNSTAT vs EP+MDRNSTAT) Median --4:29 EP vs 4:07 vs 4:01 vs 4:05 and 7:19 vs 7:06 vs 6:25 vs 6:48 -2:06 vs 2:08 vs 1:10 vs 1:55 and 4:57 vs 4:40 vs 4:19 vs 4:40 -2.22% vs 1.9% vs 0.53% vs 1.50% -0.16% vs 0.08% vs 0.0% vs 0.06%	-Single-center, not blinded study and not completely randomized -Inclusion only coverage on weekdays	The MDRNSTAT was effective in decreasing EDLOS, physician initial assessment time and LWBS of discharged patients requiring ED services, without compromising the quality of patient care

										-1:47 vs 1:42 vs 1:02 vs 1:32 -2:16 vs 1:56 vs 0:51 vs 1:38 -3:20 vs 2:59 vs 2:40 vs 2:54		
20	Lim et al. 2013	Canada	to present an alternative approach and to compare it with the traditional approach	Modelling analysis	Academic hospital with a ED opened 24 hours and approximately 50,000 patients per year	Centralized database	15,196, April - July 2010.	Interacting pseudo-agents approach	-Patient waiting time for treatment (min) -LOS (min)	Without vs with interactions (physician high acuity/physician low acuity/delegate low acuity) Mean -0.49/0.56/0.15 vs 1.02/1.49/0.52 -85.91/118.54/114.84 vs 86.83/136.99/142.07	-Exclusion of junior and senior delegates -The entire patient flow or possible variations in routing and some complexities of the ED not included -Possible underestimate of total LOS and resource utilization -Implication of commercially available software	The interaction between physician and delegate can have an impact on predicted patient throughput and waiting time
21	Muntlin et al. 2013	Sweden	to investigate the effects of teamwork in a ED on lead times and patient flow	Longitudinal, non randomized intervention study with a mixed-method design	University (level 1 trauma) hospital with > 55,000 patients per year	EMR and Electronic tracking system	2,562 patients, 10 weeks (3 follow-up periods: 5, 11 and 16 months)	Introduction of multi-professional teams by reorganization of the work processes	-Patients handled within teamwork time (%) -patients handled within the 4-hour target (%)	Control vs intervention vs 5 vs 11 vs 16 months -71% vs 73% vs 72% vs 67% vs 76% -59% vs 60%-65% (range for	-Study set in the ED's section of internal medicine -2-week periods -Staff not blinded -Use of registry data	Teamwork system seems to contribute to quality improvement ED in terms lead time, improve patient

									-time to physician (min)	intervention group and 5 and 11 months group) vs 71% Control vs 16 months: Median -53 vs 42	for time report	safety by fostering a safer and accurate communication between staff members and patients
22	Storm-Versloot et al. 2013	Amsterdam, Netherlands	to compare performance measures over levels of urgency before and after the implementation of the MTS at an ED	Prospective, single-center, 'before' and after' study	University teaching hospital (with a level 1 trauma center with >31 000 attended patients per year)	Clinical records and patient form	907 (before implementation) 901 (after implementation), October 2007	Implementation of the MTS	-Entrance time (hours and min) -waiting time (hours and min) -treatment time (hours and min) -LOS (hours and min)	-Before vs after implementation: Median -0.05 vs 0.02 -0.10 vs 0.12 -1.06 vs 1.20 -1.30 vs 1.45	-Before and after test design -Relatively long time interval -Mediocre response rate between both measurements	Implementing MTS is not sufficient to improve the efficiency and quality of EDs
23	Casalino et al. 2012	Paris, France	to determine the association between ED quality, input and output associated variables	1 year, prospective, observational, cohort study	University hospital with approximately 60,000-65,000 visits per year	EMR	67,307, April 2009 – March 2010	EDQPI	-Time to triage nurse (min) -time to ED provider (min) -patients admitted to hospital (%) -LOS (min)	Bad day vs best day Mean (±SD) -13 (±4) vs 10.9 (±3.2) -78.1 (±18.3) vs 59.2 (±11.4) -59.3% vs 39.0% Non admitted and admitted -181.7 (±25.6) vs 144.6 (±19.4) and 328.7	-Quality of performance indicator of ED not only accepted -Effect of study design on casual changes in patient flow -Use of administrative data collected for pilotage purposes -Lack of data information about hospital	Measurement of time interval metrics is a useful tool to evaluate ED processes , performance and quality of care

										(±78.9) vs 286 (±88.8)	occupancy rates, processes of care and organizational procedures	
24	Hogan et al. 2012	Hamburg, Germany	to create an improved working ED (that cuts patient waiting times for first specialty physician contact)	Observational, comparative treatments month study	Hospital with approximately 43,498 patients (year 2008) and 57,641 patients (year 2010)	Hospital contacts	3,230 (February 2008, without intervention) and 3,269 (February 2010, with intervention)	First View Concept	-Waiting time before first doctor contact (min)	Before vs after intervention Median -47.6 vs 11.2	NR	A reduction in waiting times can be achieved by new forms of organization based on industrial flow principles
25	Nestler et al. 2012	Rochester, UK	to evaluate whether a PA, acting as a TLP, would shorten LOS and decrease LWBS rates	Observational cohort, controlled, before-and-after study	Academic tertiary care hospital (Level I trauma center) with approximately 72,000 patient/ visits per year	EMR and electronic ED tracking system	371 (control dates) 353 (pilot dates), May 2, 4, 9, 11, 16, 18, 25, June 1 and April 4, 6, 11, 13, 18, 20, 28, 30, 2011	TLP	-LOS (min) -Waiting room (min) -Treatment room (min) -LWBS (%)	Control vs pilot dates Median -270 vs 229 –70 vs 69 -187 vs 151 -9.7% vs 1.4%	-Single-center study -TLP shifts or the days not randomized -Exclusion of other co-interventions during the study periods	The addition of a PA as a TLP was associated with a decrease in median total LOS, and a lower proportion of patients who LWBS
26	Welch et al. 2011	Salt Lake City, US	to describe how 2 community hospital EDs improved door-to-physician times using reliability tools and strategies	Prospective data analysis	2 community hospitals (Cottonwood and Alta View) EDs with approximately 53,000 and 28,000 visits per year	ED Data Mart: home grown information system and data repository	81,000 census (for 3 months prior to the study period and 7 months of the study period), October 2005 - June 2006	3 reliability strategies of door-to-physician improvement project: -prompts and reminders -awareness and training; -feedback loop	-Door-to-physician time (min) -LWBS (%)	Before intervention vs after intervention (Cottonwood/Alta View) Median Hospital) -51/47 vs 31/27	- Generalizability of result due to use of homegrown tracking system -ED physician group and a health care	The tools had a positive effect and both hospitals showed significant and sustained improvement

										-3%/2% vs -2%/1.4%	system as data source -Possible confounder due to physicians recording activities	
27	Baumlin et al. 2010	New York City, US	to evaluate implementation of a fully integrated EDIS	Observational, pre-post intervention study	Hospital with approximatively 75,677 (year 2001) and 76,903 (year 2005) ED visits	Hospital electronic data repository with patient tracking	508 (pre-intervention 691 (post-intervention), year 2001 and 2005	EDIS	-LOS (hour) -Door to doctor time (hour) -Doctor to disposition time (hour) -Disposition to discharge time (hour) -CT TAT (hour) -Laboratory TAT (hour) -X ray TAT (hour)	Pre vs post intervention Median -6.69 vs 4.75 -1.22 vs 0.68 -3.64 vs 1.74 -6.77 vs 4.90 -3.89 vs 2.33 -2.03 vs 1.44 -0.92 vs 0.74	-Additional work for department staff for data entry -4 year difference between the 2 data collection periods of the study -Changes within the ED that occurred during post intervention data collection period: possible confounders	EDIS implementation and process redesign led to decreased patient throughput times and improved ED efficiency
28	Ng et al. 2010	Windsor, Ontario Canada	to improve recognition of ED measures	Before and after study	ED regional referral hospital center with approximately 450,000 patients and 55,000 ED visits per year	Hospital health records	820, April 2005 - September 2005/ October 2005 - March 2006/ April 2006 - March 2007	Lean principles of the Toyota Production System	-Time to see a physician (min) -LOS (hour)	Before Lean (year 2005) vs after Lean (year 2006) vs after Lean (year 2007) Mean -111 vs 89 vs 78	-Lack of an ED information system and a central visual signal -Limited generalizability	Lean manufacturing principles can improve the flow of patients through the ED,

									-patients who LWSP (%) -overall patient satisfaction score (%) -admitted inpatients in the ED at 6:00 am (n)	-3.6 vs 3.3 vs 2.8 -7.1% vs 5.0% vs 4.3% -79.8% vs 82.0% vs 83.1% -1.8 vs 4.1 vs 6.1	-Possible incorrectly assigned and reassigned patients procedures	resulting in greater patient satisfaction along with reduced time spent by the patient in the ED

ACT Australian Capital Territory

BW BloodWork

CDU Clinical Decision Unit

CMI Case Mix Index

CMT Capacity Management Technology

CTAS Capacity Assigning Acuity Scores

DEA Data Enveloping Analysis

DES Discrete Event Simulation

DLOS Discharge length of stay

ED Emergency Department

EDDC Emergency Department Data Collection

EDIS Emergency Department Information System

EDQPI ED Quality and Performance Indicator

EMR Electronic Medical Record

EP Emergency Physician

EPR Electronic Patient Records DI Diagnostic Imaging

eSBAR: electronic Situation, Background, Assessment and Recommendation

ESI

FHR: Four-Hour Rule

FMC First Medical Contact

HMDC Hospital Morbidity Data Collection

ITT Intend-To-Treat

KPI Key Performance Indicator

LBVC Left Before Visit Complete

LWBS Left Without Being Seen

LWSP Left Without Seeing a Physician

MDRNSTAT Physician (MD) - Nurse (RN) Supplementary Team At Triage

MTS Manchester Triage System

NR Not Reported

NSW New South Wales

PA Physician Assistant

PIT Provider In Triage

RTM Ready To Move

TAT Turn Around Time

TLP Triage Liaison Provider

WA-FHR Wester Australia - For Hour Rule