

Citation Report

PMID	Category	Key Words	Author	Title	Citation	DOI	Comment
11714895	Randomized Trial	Rate of Administration, Adverse Events, Other	Marsch LA, Bickel WK, Badger GJ, et al.	Effects of Infusion Rate of Intravenously Administered Morphine on Physiological, Psychomotor, and Self-Reported Measures in Humans	J Pharmacol Exper Therap 2001;299:1056-1065 http://jpet.aspetjournals.org/content/299/3/1056?casa_token=_SQH1asGLnAAAAA%3AO4OPtUf3xE8TZdT_cLxYrfKzSs1O2myTYaDS79j_oCKLwtCEbaXZ4vp_e0ZvkrUXDEVYPPbhwTE	see citation	Human volunteer trial indicates that a rapid onset opioid may be more likely to create abuse but these authors found that faster morphine administration (2 vs. 15 min) produced higher plasma levels and drug effect that may contribute to abuse liability.
27128107	Randomized Trial	Safety, Error, Dilution, Rate of Administration, Direct Observation, Ready-to-administer, Prefilled Syringe, Labeling	Burger M, Degnan D.	Comparative Safety, Efficiency, and Nursing Preference Among 3 Methods for Intravenous Push Medication Preparation: A Randomized Crossover Simulation Study	J Patient Saf. 2019 Sep;15(3):238-245.	10.1097/PTS.000000000000269	Prefilled syringes allow for faster medication preparation and reduced preparation errors with vial-and-syringe process. Compared Carpuject and BD Simplest.
32131580	Randomized Trial	Safety, Rate of Administration, Adverse Events, Nurse Administration, Economic Impact	Dadpour B, Vahabzadeh M, Mostafazadeh B.	Comparison of the efficacy of an infusion pump or standard IV push injection to deliver naloxone in treatment of opioid toxicity	Acute Crit Care. 2020 Feb;35(1):38-43.	10.4266/acc.2020.000010	Intermittent IV push naloxone compared with a naloxone infusion for ICU patients on mechanical ventilation after opioid overdose were compared. Infusion produced fewer complications and shorter LOS than intermittent IV push.
3233896	Randomized Trial	Safety, Dilution, Adverse Events, Phlebitis, Economic Impact	Garrelts JC, Ast D, LaRocca J, Smith DF Jr, Peterie JD.	Postinfusion phlebitis after intravenous push versus intravenous piggyback administration of antimicrobial agents	Clin Pharm. 1988 Oct;7(10):760-5.		IV push beta-lactam antibiotics were compared and overall there was no difference in phlebitis rate (41 vs 47%) but for catheters discontinued due to phlebitis, the duration of use was longer for IV push 45 +/- 21 hr vs. 36 hr +/- 18hr.

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31118678	Randomized Trial	Safety, Rate of Administration, Adverse Events, Direct Observation, Nurse Administration	Navari RM, Mosier MC.	Crossover safety study of aprepitant: 2-min injection vs 30-min infusion in cancer patients receiving emetogenic chemotherapy	Onco Targets Ther. 2019 Apr 30;12:3277-3284.	10.2147/OTT.S201609	Compared new formulation of HTX-019 and rate of administration vs. effectiveness at preventing cancer induce N&V.
25364017	Randomized Trial	Adverse Events, Ready-to-administer, Prefilled Syringe, Patient Satisfaction	Mancini D, Vaillancourt R, Pouliot A, Lin A, Sharp D.	Taste and Odour Disturbances in Pediatric Patients Undergoing IV Flush with Normal Saline Administered by Prefilled or Freshly Prepared Syringes: Randomized Single-Blind Study	Can J Hosp Pharm. 2014 Sep;67(5):353-7.	10.4212/cjhp.v67i5.1389	Pediatric pts. Randomized to flush with prefilled syringe vs. hospital prepared syringe. 73% reported taste or odor disturbance with commercial syringe and 4% of the fresh hospital syringe. The source of the effect is not known.
31811297	Guideline/Practice Statement	Safety, Compatibility, Drug Administration, Ready-to-administer, Prefilled Syringe	Gabay M, Hertig JB, Degnan D, et al.	Third consensus development conference on the safety of intravenous drug delivery systems- 2018	Am J Health-Syst Pharm 2020;77(3);215-220.	doi.org/10.1093/ajhp/zxz277	Conference concluded that ready-to-use was safest but threats to safety include supply chain/shortages & lack of standardization. Suggested safety improvements.
30257844	Guideline/Practice Statement	Safety, Error, Ready-to-administer, Prefilled Syringe	Billstein-Leber M, Carrillo JD, Cassano AT, et al.	ASHP Guidelines on Preventing Medication Errors in Hospitals	Am J Health-Syst Pharm 2018;19:1493-1517	10.2146/ajhp170811	Reviews a variety of strategies for error risk identification and reduction, including ready-to-use forms
	Guideline/Practice Statement	Safety, Error, Preparation, Drug Administration, Ready-to-administer, Nurse Administration, Prefilled Syringe	ISMP	ISMP Safe Practice Guidelines for Adult IV Push Medications 2015	https://www.ismp.org/sites/default/files/attachments/2017-11/ISMP97-Guidelines-071415-3.%20FINAL.pdf		Review of issues that reduce medication safety and guidelines for safe IV Push medication administration.

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	Guideline/Practice Statement	Safety, Error, Dilution, Drug Administration, Direct Observation, Ready-to-administer, Nurse Administration, Other Provider Administration, Prefilled Syringe	Joint Commission Resources	Ready-to-Administer (RTA) Injectable Medication Safety Tracer Tool	https://www.rtamedsafety.com/documents/RTA_MedSafety_Assessment-PharmacyIVRoom.pdf		This tool allows hospitals to assess medication safety with current practices in purchasing, ordering, and order verification. It has specific tools for settings like the IV room, Nursing unit, and Anesthesia.
27612197	Guideline/Practice Statement	Safety, Error, Drug Administration, Nurse Administration, Education	Shastay AD.	Evidence-based safe practice guidelines for I.V. push medications	Nursing. 2016 Oct;46(10):38-44.	10.1097/01.NURSE.0000494641.31939.46	Review of ISMP guidelines
	Guideline/Practice Statement	Dilution, Drug Administration, Prefilled Syringe, Syringe Reuse, Infection, Infection Control	Dolan SA, Arias KM, Felizardo G, et al.	APIC Position Paper: Safe injection, infusion, and medication vial practices in health care (2016)	https://www.apic.org/Resource_/TinyMceFileManager/Position_Statements/2016APICSIPPositionPaper.pdf		This statement was an update of their earlier position paper and describes unsafe practices and suggestions to improve safety or reduce risk of infection.
	Guideline/Practice Statement	Safety, Drug Administration, Central, Peripheral, Nurse Administration, Midline Catheter, Education	Rowley S, Clare S for the Association for Safe Aseptic Practice	Standardizing the critical clinical competency of aseptic, sterile, and clean techniques with a single international standard: Aseptic Non Touch Technique (ANTT)	JAVA 2019; 24(4): 12-17.	10.2309/j.java.2019.004.003	Guidance for aseptic insertion and handling of IV line

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33394637	Guideline/Practice Statement	Safety, Preparation, Dilution, Drug Administration, Phlebitis, Central, Peripheral, Prefilled Syringe, Nursing Practice, High Alert, Peri-operative Setting, Catheter Complications, Midline Catheter, Education, Quality Improvement	Gorski LA, Hadaway L, Hagle ME, et al.	Infusion Therapy Standards of Practice 2021	J Infusion Nurs. 2021; 44(1S): S1-S224	10.1097/NAN.0000000000000396	This comprehensive update sets Standards for infusion therapy practice, patient and clinician safety, infection prevention/control, equipment, device selection/placement/management, complications, special devices, and infusion therapies.
30147136	Review	Safety, Drug Administration	Spencer S, Ipema H, Hartke P, et	Intravenous push administration of antibiotics: Literature and considerations	Hosp Pharm. 2018;53(3):157-169.	doi.org/10.1177/0018578718760257	
	Review	Safety, Error, Drug Administration, Ready-to-administer, Prefilled Syringe	Montney J, Stinnett JE	Are prefilled syringes worth it?	Outpatient Surgery Magazine August 2017 http://www.outpatientsurgery.net/surgical-facility-administration/surgical-supplies/are-prefilled-syringes-worth-it--08-17	see citation	Brief review of pros and cons of prefilled syringes
	Review	Safety, Error, Preparation, Rate of Administration, Drug Administration, Adverse Events, Phlebitis, Nurse Administration, Prefilled Syringe	Spader C	Myths of IV push administration	https://www.myamericannurse.com/myths-of-i-v-push-administration/ May 3, 2019	see citation	Poses myths and truths about the need to dilute medications and other medication safety issues such as transferring between syringes, labeling, avoidance of pain

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	Review	Safety, Preparation, Drug Administration, Adverse Events, Central, Nurse Administration, Nursing Practice	CDC National Center for Emerging and Zoonotic Infectious Diseases	Empowering nurses to protect themselves and their patients: Exploring best practices in injection safety	https://www.youtube.com/watch?v=MuaCuRXf5wM February 22, 2018	see citation	A You Tube video presentation
23322752	Review	Safety, Error, Dilution, Adverse Events, Error Rates, Nurse Administration, Other Provider Administration, Nursing Practice	McLeod MC, Barber N, Franklin BD	Methodological variations and their effects on reported medication administration error rates	BMJ Qual Saf 2013;22:278–289	10.1136/bmjqs-2012-001330	Evaluated literature and noted significant methodological variation that impacts error rate reporting. They have recommended design for future studies.
40320	Review	Safety, Error, Error Rates, Ready-to-administer, Other Provider Administration, Prefilled Syringe	Wild D	The benefits of prefilled syringes	www.pharmacypracticenews.com/Article/PrintArticle?articleID=40320	see citation	Brief interview with 2 researchers. See Anesthesiology 2016, J Clin Anesth 2016 and J Patient Saf 2016
	Review	Safety, Error, Ready-to-administer, Other Provider Administration, Prefilled Syringe	Viscusi ER, Wagner D	The roles of the anesthesiologist and pharmacist in ensuring safe handling and administration of opioids.	Anesthesiology News Suppl. 2018	see comment	https://www.anesthesiologynews.com/Monographs-and-Whitepapers/Article/08-18/The-Roles-of-the-Anesthesiologist-and-Pharmacist-in-Ensuring-Safe-Handling-and-Administration-of-Opioids/52586
28781499	Review	Error, Dilution, Drug Administration, Adverse Events, Ready-to-administer, Nurse Administration, Prefilled Syringe	Grissinger, M	Some IV medications are diluted unnecessarily in patient-care areas, creating undue risk.	P T 2017;42:490-492, 508 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5521294/	see citation	Reports on the ISMP Survey of nurses in 2014 regarding use of prefilled syringes and use of dilution strategies. Author reports criteria for appropriate dilution.

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20844691	Review	Error, Preparation, Dilution, Adverse Events, Ready-to-administer, Nurse Administration, Prefilled Syringe, Labeling	Grissinger, M	Reducing Errors with Injectable Medications Unlabeled Syringes Are Surprisingly Common	P T .2010;35:428, 451 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2935650/	see citation	Presents cases of patient injury to emphasize the need for labeling and other med safety strategies.
	Review	Safety, Error, Dilution, Drug Administration, Ready-to-administer, Prefilled Syringe, Nursing Practice	Jacobi J, Burger M	Is dilution destroying your sterile products?	see comment	see comment	https://www.pharmacypracticenews.com/Policy/Article/03-18/Is-Dilution-Destroying-Your-Sterile-Products-/48354
32287169	Review	Safety, Error, Dilution, Ready-to-administer, Prefilled Syringe	Degnan DD, Bullard TN, Davis MBH.	Risk of Patient Harm Related to Unnecessary Dilution of Ready-to-Administer Prefilled Syringes: A Literature Review	J Infuse Nurs. 2020 May/Jun;43(3):146-154.	10.1097/NAN.000000000000366	Reviews literature describing potential harms associated with unnecessary dilution of IV push medications and published guidelines for these products.
32332508	Review	Error, Dilution, Ready-to-administer, Prefilled Syringe, Nursing Practice	Deutsch L.	Dilution is no solution	Nursing. 2020 May;50(5):61-62.	10.1097/01.NURSE.0000659316.76576.58	Reviews the issues around unnecessary dilution of IV push medications and uses stories to demonstrate the process
8807912	Review	Drug Administration, Peripheral, Nurse Administration, Nursing Practice	McConnell EA.	Administering an I.V. push injection through an existing peripheral line	Nursing. 1996 Aug;26(8):24.		
26547575	Review	Safety, Error, Preparation, Dilution, Adverse Events, Nurse Administration, Nursing Practice, Labeling	Paparella SF, Mandrack MM.	IV Push Medication Administration: Making Safe Choices; Choosing Best Practice	J Emerg Nurs. 2016 Jan;42(1):64-7.	10.1016/j.jen.2015.09.016	Review of common errors in IV preparation and administration to ED patients.

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29112582	Review	Safety, Peripheral, Nurse Administration	Lenz JR, Degnan DD, Hertig JB, Stevenson JG.	A review of best practices for intravenous push medication administration	J Infusion Nurs 2017;40 (6);354-358.	doi.org/10.1097/nan.00000000000000247	Review of 2015 ISMP safe practice guidelines
30846139	Review	Safety, Error, Preparation, Dilution, Ready-to-administer, Prefilled Syringe, Labeling	Paparella SF.	IV Push Medication Matters: New Survey Points to Slow Adoption of Best Practices	J Emerg Nurs. 2019 Mar;45(2):202-205.	10.1016/j.jen.2018.12.011	Reports on surveys done by ISMP and ASHP to educate their readers about IV Push practices that should be avoided.
23860193	Review	Safety, Error, Adverse Events, Nurse Administration, Nursing Practice	James, John T	A New, Evidence-based Estimate of Patient Harms Associated with Hospital Care	J Patient Saf 2013;9: 122-128	10.1097/PTS.0b013e3182948a69	Review of 4 studies looking at medical errors and discuss tools to identify errors from medical records. Not specific to IV Push.
15452531	Review	Safety, Error, Adverse Events, Nurse Administration	Papparella S	Avoiding disastrous outcomes with rapid intravenous push medications.	J Emerg Nurs 2004; 30:478-480	10.1016/j.jen.2004.08.002	Case of rapid IV push calcium administration with resulting asystole in a verapamil toxicity patient to educate on proper terminology (avoid push or bolus term and state IV over ___ min.
32151563	Review	Error, Other, Labeling, Lighting/Illumination, Ampule, Misreading	Borradale H, Andersen P, Wallis M, Oprescu F	Misreading injectable medications - causes and solutions: An integrative literature review	Joint Commission J Qual Pat Saf 2020; 46:291-298	10.1016/j.jcjq.2020.01.007	Studies reporting on the effects of lighting level, packaging, labeling, and visual acuity were reviewed for potential contribution to misreading label on an injectable product.
28902007	Observational	Safety, Preparation, Dilution, Drug Administration, Direct Observation, Error Rates, Ready-to-administer, Nurse Administration, Nursing Practice	Hertig JB, Degnan DD, Scott CR, et al.	A comparison of error rates between intravenous push methods: A prospective, multisite, observational study	J Patient Saf 2018;14(1);60-65.	doi.org/10.1097/pts.00000000000000419	RTA had lower observed error rate (2.5%) vs. traditional practice (10.4%) with 329 observations in 3 health-system sites. Still need to quantify potential harm with these errors.

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11194136	Observational	Error, Drug Administration, Direct Observation, Error Rates, Nurse Administration	Dean B, Barber N	Validity and reliability of observational methods for studying medication administration errors	Am J Health-Syst Pharm 2001;58:54-59	10.1093/ajhp/58.1.54	UK hospitals with consecutive medication administrations observed. Concluded that observational methods to identify drug administration errors are valid and reliable.
26845139	Observational	Safety, Error, Drug Administration, Direct Observation, Ready-to-administer, Other Provider Administration, Prefilled Syringe	Yang Y, Rivera AJ, Fortier CR, Abernathy JH	A Human Factors Engineering Study of the Medication Delivery Process during an Anesthetic	Anesthesiology 2016; 124:795-803	10.1097/ALN.0000000001040	System vulnerabilities compared for self-filled vs. pre-filled syringes in the OR. Concluded the prefilled have the potential to improve safety and efficiency.
25630893	Observational	Safety, Error, Other, Nursing Practice, Quality Improvement	Hanrahan K, Wagner M, Matthews G, et al. Practice	Sacred Cow Gone to Pasture: A Systematic Evaluation and Integration of Evidence-Based Practice	Worldviews on Evidence-Based Nursing, 2015; 12:1, 3–11.	10.1111/wvn.12072	A strategic approach to eliminating outdated practices when introducing evidence-based practices and testing implementation strategies.
14532365	Observational	Safety, Error, Preparation, Dilution, Drug Administration, Adverse Events, Direct Observation, Error Rates, Nurse Administration	Taxis K, Barber N	Causes of intravenous medication errors: an ethnographic study	Qual Saf Health Care 2003;12:343–348	10.1136/qhc.12.5.343	Observational study of IV medication errors
29880520	Observational	Preparation, Dilution, Compatibility, Drug Administration, Nurse Administration, pH	Gandhi RG, Steiger SN, Elshaboury RH, Lund JT.	I.V. push administration of medications reconstituted with 0.9% sodium chloride injection	Am J Health Syst Pharm. 2018 Jun 15;75(12):851-852.	10.2146/ajhp180132	Alternatives to sterile water were needed during a shortage and 0.9% NaCl was tested for several medications and found acceptable for most drugs, other than cefepime where high osmolarity may cause phlebitis.

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29095181	Observational	Preparation, Drug Administration, Nursing Practice, Economic Impact, Waste	McLaughlin JM, Scott RA, Koenig SL, Mueller SW.	Intravenous Push Cephalosporin Antibiotics in the Emergency Department: A Practice Improvement Project	Adv Emerg Nurs J. 2017 Oct/Dec;39(4):295-299.	10.1097/TME.000000000000160	Topic arose when minibags were in short supply, but has been sustained for efficiency and economics. This paper showed reduced time to drug administration and reduced costs with IV push.
2213947	Observational	Nurse Administration, Economic Impact, Quality Improvement	Weigelt JA, Dyke C, Martin RL.	Alternative delivery system for controlled drugs in the surgical intensive care unit	J Trauma. 1990 Sep;30(9):1141-6; discussion 1146-7.	10.1097/00005373-199009000-00010	Compared morphine IV push vs. via a nurse-controlled device (NCA-essentially a PCA run by nurses) and reduced time to administer and costs.
24250594	Observational	Safety, Error, Rate of Administration, Adverse Events, Direct Observation, Nurse Administration	Abbasinazari M, Hajhossein Talasaz A, Mousavi Z, Zare-Toranposhti S.	Evaluating the frequency of errors in preparation and administration of intravenous medications in orthopedic, general surgery and gastroenterology wards of a teaching hospital in Tehran	Iran J Pharm Res. 2013 Winter;12(1):229-34. https://pubmed.ncbi.nlm.nih.gov/24250594/	see citation	Observational study of med prep and admin by nurses and most common error was rapid rate, but also aseptic technique, diluent selection, monitoring for phlebitis, and drug incompatibility were observed. Indicated need for standardization and education.
29698190	Observational	Error, Drug Administration, Direct Observation, Nurse Administration, High Alert	Ding Q, Barker KN, Flynn EA, Westrick SC, Chang M, Thomas RE, Braxton-Lloyd K, Seseck R.	Incidence of Intravenous Medication Errors in a Chinese Hospital	Value Health Reg Issues. 2015 May;6:33-39.	10.1016/j.vhri.2015.03.004	Observed frequent errors by nurses - dosing, time of admin., omission, extra dose. Rate was 9.1% excluding wrong time errors. Concluded that pharmacists needed to have a role in IV medication processes.
29873424	Observational	Safety, Error, Direct Observation, Hazardous, Oncology	Al Khawaldeh TA, Wazaify M.	Intravenous cancer chemotherapy administration errors: An observational study at referral hospital in Jordan	Eur J Cancer Care (Engl). 2018 Jul;27(4):e12863.	10.1111/ecc.12863	Oncology nurses were observed and errors were frequent in the process and aseptic technique. Nurses trained in chemo prep and admin had a higher error rate. Nevertheless, the authors concluded that more education was needed.

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24835141	Observational	Error, Drug Administration, Direct Observation, Nurse Administration, Nursing Practice, Quality Improvement	Donaldson N, Aydin C, Fridman M.	Predictors of unit-level medication administration accuracy: microsystem impacts on medication safety	J Nurs Adm. 2014 Jun;44(6):353-61.	10.1097/NNA.000000000000081	Direct observational assessment of 15600 doses found distractions and interruptions were common safe practice deviations. Predicted a 46% reduction in admin. error if 5% decrease in safe practice deviations. Staffing is also an important factor.
23129865	Observational	Adverse Events, Central, Peripheral, Prefilled Syringe, Patient Satisfaction, Pharmacy Preparation	Celetti SJ, Vaillancourt R, Pascuet E, Sharp D.	Taste and/or Odour Disturbances in Pediatric Patients Undergoing IV Flush with Normal Saline Administered by Prefilled Syringe	Can J Hosp Pharm. 2012 Sep;65(5):368-72.	10.4212/cjhp.v65i5.1174	73% of children detected alteration in taste or smell following saline flush with a commercial prefilled syringe.
31455315	Cohort	Safety, Drug Administration, Nurse Administration, Other Provider Administration	Hayashi T, Hutin YJ-F, Bulterys M, et al.	Injection Practices in 2011-2015: A Review Using Data From the Demographic and Health Surveys (DHS)	BMC Health Serv Res 2019 Aug 27;19(1):600	10.1186/s12913-019-4366-9	Database search for unsafe injection practices, such as syringe re-use.
15933316	Cohort	Safety, Error, Preparation, Dilution, Rate of Administration, Drug Administration, Direct Observation, Ready-to-administer, Nurse Administration, Nursing Practice	Cousins DH, Sabatier B, Begue D, et al.	Medication errors in intravenous drug preparation and administration: a multicentre audit in the UK, Germany and France	Qual Saf Health Care 2005;14:190–195	10.1136/qshc.2003.006676	Prospective audit of error rates comparing 3 sites evaluating labeling, dilution, rate of administration, and aspect technique.
32447650	Cohort	Safety, Dilution, Rate of Administration, Drug Administration, Nurse Administration, Economic Impact	Burns D, Kula J, Marshall S, Ashworth E, Ornelas M.	Best Practice Approach to Successful Conversion of Fosaprepitant to Aprepitant IV in a Large Multisite Community Oncology Infusion Center: A Retrospective Analysis	Adv Ther. 2020 May 23. Ahead of print	10.1007/s12325-020-01377-z	Compared fosaprepitant IVPB to aprepitant IVP over 2 min and improved efficiency and reduced cost.

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10172048	Cohort	Dilution, Drug Administration, Adverse Events, Phlebitis, Economic Impact	Garrelts JC, Smith DF, Ast D, Peterie JD.	A comparison of the safety, timing and cost-effectiveness of administering antibiotics by intravenous bolus (push) versus intravenous piggyback (slow infusion) in surgical prophylaxis	Pharmacoeconomics. 1992 Feb;1(2):116-23.	10.2165/00019053-199201020-00008	Compared IV push cefmetazole vs. IVPB (study design not known) and concluded IV push avoided more costs, was safe and phlebitis did not occur with either route (unknown duration of f/u)
32470139	Cohort	Safety, Drug Administration, Adverse Events, Nurse Administration	Hays WB, Flack T.	Safety and tolerability of i.v. push piperacillin/tazobactam within an emergency department	Am J Health Syst Pharm. 2020 May 29;zxaa114.	10.1093/ajhp/zxa114	Retrospective review of 299 patients for safety and tolerance of IV push vs IVPB piperacillin/tazo in the ED. Allowed faster administration without documented infusion-related reactions.
10048883	Cohort	Safety, Rate of Administration, Drug Administration, Nurse Administration, Economic Impact, Home Care	Nowobilski-Vasilios A, Poole SM.	Development and preliminary outcomes of a program for administering antimicrobials by i.v. push in home care	Am J Health Syst Pharm. 1999 Jan 1;56(1):76-9.	10.1093/ajhp/56.1.76	Retrospective data following a change in process to administer specified antimicrobial agents IV push instead of IVPB> Most given via peripheral site.
30190292	Cohort	Safety, Dilution, Drug Administration, Osmolarity	Pettit NN, Nguyen CT, Stahle S, Wong M, Bastow S, Pisano J.	Implementing i.v. push administration of piperacillin-tazobactam in response to shortage of small-volume infusion bags	Am J Health Syst Pharm. 2018 Sep 15;75(18):1358-1359.	10.2146/ajhp180163	Measured osmolarity of pip/tazo when diluted for IV push and added it to the list of agents given via IV Push during minibag shortage- ED and acute care units only (not ICU).
10476138	Cohort	Dilution, Rate of Administration, Drug Administration, Adverse Events, Phlebitis, Home Care, Patient Satisfaction	Poole SM, Nowobilski-Vasilios A, Free F.	Intravenous push medications in the home	J Intravenous Nurs. 1999 Jul-Aug;22(4):209-15. https://pubmed.ncbi.nlm.nih.gov/10476138/	see citation	Reviewed reports of N=1116 cases for self-administered IV push vs IVPB phlebitis rates and patient satisfaction.

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31495250	Cohort	Safety, Dilution, Rate of Administration, Adverse Events	Tjugum SL, Hedrick TL, Jean SJ, Heeney SA, Rohde KA, Campbell-Bright SL.	Evaluation of the Safety of Intravenous Thiamine Administration in a Large Academic Medical Center	J Pharm Pract. 2019 Sep 8;897190019872584.	10.1177/0897190019872584	Hospital with inconsistent practice regarding thiamine administration compared adverse event rates (retrospective) for 200mg doses IV push vs infusion, and found no significant difference (likely lack of documentation or type II error, however).
10873877	Cohort	Safety, Drug Administration, Adverse Events, Effectiveness	Van Wyck DB, Cavallo G, Spinowitz BS, Adhikarla R, Gagnon S, Charytan C, Levin N.	Safety and efficacy of iron sucrose in patients sensitive to iron dextran: North American clinical trial	Am J Kidney Dis. 2000 Jul;36(1):88-97.	10.1053/ajkd.2000.8276	Patients with prior reactions to iron dextran were given iron sucrose 100mg IV push on dialysis, and safety was demonstrated compared with a 15 min. infusion.
31932197	Cohort	Safety, Dilution, Rate of Administration, Drug Administration, Adverse Events, Phlebitis	McLaughlin K, Joyal K, Lee S, Corrado M, Marquis K, Anger K, Szumita P.	Safety of intravenous push thiamine administration at a tertiary academic medical center	J Am Pharm Assoc (2003). 2020 Jan 10;S1544-3191(19)30544-8.	10.1016/j.japh.2019.12.005	IV push doses up to 250mg were tolerated without any anaphylaxis and few infusion site
29949010	Cohort	Safety, Dilution, Rate of Administration, Drug Administration, Adverse Events	Davidson KE, Newell J, Alsherbini K, Krushinski J, Jones GM.	Safety and Efficiency of Intravenous Push Lacosamide Administration	Neurocrit Care. 2018 Dec;29(3):491-495.	10.1007/s12028-018-0560-6	Confirmed a prior study that IV push dosing up to 80 mg/min was tolerated without infusion reactions. IV push was faster therapy than IVPB.
32686466	Cohort	Safety, Rate of Administration, Drug Administration	McLaughlin K, Carabetta S, Hunt N, et al.	Safety of intravenous push lacosamide compared with intravenous piggyback at a tertiary academic medication center.	Ann Pharmacother 2021; 55(2):181-186	10.1177/1060028020943569	Lacosamide may be considered a safe alternative to IVPB administration when considering the potential for hypotension, bradycardia, sedation, and IV site reactions, based on this retrospective cohort report.

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34081297	Cohort	Safety, Adverse Events	Adams T, Greathouse K	Evaluation of time to administration, benzodiazepine use, and safety of intravenous push levetiracetam in a neuro-spine intensive care unit	Neurocrit Care. 2021; online ahead of print	10.1007/s12028-021-01237-w	There was no difference in adverse events before vs. after a protocol change from IVPB to IV Push administration of up to 2000 mg levetiracetam. There were beneficial differences in timeliness and a reduction in benzodiazepine doses while waiting.
33068313	Cohort	Preparation, Rate of Administration, Drug Administration, Effectiveness, Quality Improvement	Marsh K, Dubrovskaya Y, Jen S-PP, et al.	Intravenous push versus intravenous piggyback beta-lactams for the empiric management of gram-negative bacteremia.	J Clin Pharm Ther. 2021; 46(2):373-381	10.1111/jcpt.13291	Study focused on infection-related outcome during a minibag shortage period and no differences were found based on rate of administration.
33302785	Cohort	Rate of Administration, Adverse Events, Nurse Administration, Economic Impact	Academia EC, Jenrette JE, Mueller SW, McLaughlin JM.	Evaluation of first-dose, intravenous push penicillins and carbapenems in the emergency department	J Pharm Pract. 2020 on line ahead of print	0.1177/0897190020977758	IVP administration reduced time to first dose and cost savings vs. IVPB without an increase in adverse events.
25477584	Cases/Case	Rate of Administration, Adverse Events, Home Care	Caulder CR, Sloan A, Yasir A, Bookstaver PB.	Infusion-related reaction following daptomycin two-minute rapid intravenous administration	Hosp Pharm. 2014 Jul;49(7):644-6.	10.1310/hpj4907-644	Adverse reaction to daptomycin via 2 min IV push but the patient tolerated 40 min infusions on subsequent doses.
3377616	Cases/Case	Rate of Administration, Adverse Events, Peri-operative Setting	Spengler RF, Arrowsmith JB, Kilarski DJ, Buchanan C, Von Behren L, Graham DR.	Severe soft-tissue injury following intravenous infusion of phenytoin. Patient and drug administration risk factors	Arch Intern Med. 1988 Jun;148(6):1329-33. https://pubmed.ncbi.nlm.nih.gov/3377616/	see citation	Vascular injury in cases vs. matched controls found female, smaller than 20 gauge, and faster infusion, with 2 or more doses increased the risk of injury.
	Editorial/White Paper	Safety, Error, Preparation, Dilution, Drug Administration, Ready-to-administer, Nurse Administration, Prefilled Syringe	Spader C	A matter of IV push drug safety	May 3, 2019 see comment	see comment	https://www.myamericannurse.com/wp-content/uploads/2019/04/ant4-Fresenius-IV-Push-325a.pdf Discusses the 2018 ISMP survey on how nurses prepare and administer IV push medications.

PMID	Category	Key Words	Author	Title	Citation	DOI	Comment
29279297	Editorial/White Paper	Safety, Error, Other, Nursing Practice	Wang V, Maciejewski ML, Helfrich CD, Weiner BJ	Working smarter not harder: Coupling implementation to de-implementation implementation	Healthc (Amst.) 2018;6:104-107	10.1016/j.hjdsi.2017.12.004	Discuss role of de-implementation as a part of organizational change and the challenges of unlearning as part of implementation of new practice.
28438828	Editorial/White Paper	Safety, Error, Drug Administration, Ready-to-administer, Prefilled Syringe, Economic Impact, Labeling	Fanikos J, Burger M, Canada T, Ebright P, Fleming J, Harder KA, Pham JC, Sawyer MD, Stevenson JG.	An assessment of currently available i.v. push medication delivery systems	Am J Health Syst Pharm. 2017 May 1;74(9):e230-e235.	10.2146/ajhp150830	Expert panel report on the ideal ready-to-use system and assessment of currently available
10317755	Editorial/White Paper	Drug Administration, Economic Impact	Hughes TE, Suzuki NT.	IV push policy: the economic effects of IV drug administration guidelines	Hosp Formul. 1986 Jul;21(7):793-9, 802.		May be too old to acquire this paper and economics may not be relevant
	Letters	Rate of Administration, Drug Administration, Nursing Practice	Porter JJ, Lopez TC	Maximum intravenous morphine push rate: Discrepancies between the primary and tertiary literature. (letter)	J Pain Palliat Care Pharmacother 2005;19:67-68	10.1300/J354v19n01_12	The maximum rate of morphine may be ~ 5 mg/min (per 70kg) in an opioid naïve patient based on trial data and this is faster than suggested in tertiary literature.
9161666	Letters	Dilution, Economic Impact	Ambrose PG, Quintiliani R, Nightingale CH.	Pharmacoeconomic analysis of administration of famotidine i.v. push vs. intermittent slow i.v. infusion	Ann Pharmacother. 1997 May;31(5):645.	10.1177/106002809703100521	
	Miscellaneous	Safety, Error, Preparation, Dilution, Drug Administration, Adverse Events, Central, Other, Nurse Administration, Prefilled Syringe, Nursing Practice	Perz J, Kainer MA, Wiemken T	Injection safety: A system approach Medscape CE program. Slides can be downloaded	https://www.medscape.org/viewarticle/880773_slide 9/18/2017	see citation	No longer available for continuing education credit, but slides can be viewed.

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	Miscellaneous	Safety, Error, Preparation, Dilution, Drug Administration, Ready-to-administer, Prefilled Syringe, Labeling	ISMP	Some IV Medications Are Diluted Unnecessarily in Patient Care Areas, Creating Undue Risk	https://www.ismp.org/resources/some-iv-medications-are-diluted-unnecessarily-patient-care-areas-creating-undue-risk	see comment	Survey results from 1773 respondents (97% RN) in 2014 demonstrates frequent filution of meds that may be unnecessary and often leads to unlabeled or mislabeled syringes, contamination, erros.
28438821	Miscellaneous	Rate of Administration, Drug Administration, Other	Butterfield-Cowper JM, Burgner K.	Effects of i.v. push administration on Beta-lactam pharmacodynamics	Am J Health Syst Pharm. 2017 May 1;74(9):e170-e175.	10.2146/ajhp150883	Compared with a 30 min. infusion, change to IV push over 5 min. had minimal impact on the probability of target attainment for meropenem, cefepime, and aztreonam based on Monte Carlo simulation.
28625701	Miscellaneous	Safety, Ordering, Other, Nurse Administration	Kossover-Smith RA, Coutts K, Hatfield KM, et al.	One needle, one syringe, only one time? A survey of physician and nurse knowledge, attitudes, and practices around injection safety	Am J Infect Control 2017;45:1018-1023	10.1016/j.ajic.2017.04.292	A survey of physicians and nurses
	Miscellaneous	Safety, Error, Drug Administration, Adverse Events, Nursing Practice, Education, Quality Improvement	Spader C	I.V. Push medication administration	https://www.myamericannurse.com/wp-content/uploads/2019/04/ant4-Fresenius-IV-Push-325a.pdf		Comprehensive compilation of articles to educate on risk of incorrect technique and review of evidence-based practices
	Survey	Safety, Nurse Administration, Prefilled Syringe, Waste, Syringe Reuse, Education, Quality Improvement	Burger M, Cross C	One and done: Prefilled flush syringes	Am Nurs J 2021 https://www.myamericannurse.com/one-and-done-for-prefilled-flush-syringes/		Review of risks of syringe reuse and results of a nursing survey on flushing practices, saline syringe reuse, and reveals a gap between best practice and actual practice.

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28439128	Survey	Safety, Error, Dilution, Ready-to-administer, Prefilled Syringe, Nursing Practice	Heindel GA, Stivers AP.	Culture Changes Needed to Implement ISMP IV Push Guidelines	Hosp Pharm. 2017 Mar;52(3):167-168.	10.1310/hpj5203-167	Nurses at one hospital were surveyed and reported poor compliance with the 2015 ISMP Guidelines for IV push meds, esp. due to diluting, rate of administration reflected lack of awareness of optimal practice.
10030221	Quality Improvement	Drug Administration, Nurse Administration, Economic Impact, Home Care	Miano B, Wood W.	Implementation of the i.v. push method of antibiotic administration using the FOCUS/PDCA approach	Home Health Nurse. 1998 Dec;16(12):831-7.	10.1097/00004045-199812000-00007	Descriptive report of a quality improvement process change.
1442814	Quality Improvement	Dilution, Rate of Administration, Education, Quality Improvement	Sullivan V, Koch KE.	Development of i.v. push guidelines	Am J Hosp Pharm. 1992 Oct;49(10):2427, 2433.	10.1093/ajhp/49.10.2427	An early statement about the role of pharmacists to standardize information on rate of administration and provide it to nurses.