REFERENCE #	CITATION	EVIDENCE TYPE	SAMPLE SIZE/ POPULATION	INTERVENTION(S)	CONTROL/ COMPARISON	OUTCOME MEASURE(S)	CONCLUSION(S)	CONSENSUS SCORE
1	Boeker EB, de Boer M, Kiewiet JJS, Lie-A-Huen L, Dijkgraaf MGW, Boermeester MA. Occurrence and preventability of adverse drug events in surgical patients: a systematic review of literature. BMC Health Serv Res. 2013;13:364.	Systematic Review w/ Meta-Analysis	6 studies	n/a	n/a	Adverse drug events.	Adverse drug events occur in a high proportion of surgical patients but less frequently than nonsurgical patients. Of these events many are considered to be preventable. The events were found to occur in all types of procedures and during all phases of the medication process.	IIIA
2	ASHP guidelines on preventing medication errors in hospitals. Am J Hosp Pharm. 1993;50(2):305-314.	Guideline	n/a	n/a	n/a	n/a	Guidelines to assist with the prevention of medication errors.	IVC
3	Hicks RW, Wanzer L, Goeckner B. Perioperative pharmacology: a framework for perioperative medication safety. AORN J. 2011;93(1):136-142.	Expert Opinion	n/a	n/a	n/a	n/a	The medication use process is very different in the perioperative environment.	VB
4	Seidling HM, Stutzle M, Hoppe-Tichy T, et al. Best practice strategies to safeguard drug prescribing and drug administration: an anthology of expert views and opinions. Int J Clin Pharm. 2016;38(2):362-373.	Qualitative	20 international medication experts	n/a	n/a	Medication prescribing and administration processes	A multidisciplinary medication safety team should manage the medication process, computerized order entry system should be used, and medication reconciliation should be performed.	IIIB
5	Adhikari R, Tocher J, Smith P, Corcoran J, MacArthur J. A multi-disciplinary approach to medication safety and the implication for nursing education and practice. Nurse Educ Today. 2014;34(2):185-190.	Qualitative	20 nurses,3 pharmacists, 3 pharmacy technicians, 8 doctors in 2 wards in 2 Scottish hospital hospitals	n/a	n/a	Medication management practices.	A multidisciplinary approach should be used to improve medication safety and nurses need more pharmacology education.	IIIB

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6	Cousins DH, Gerrett D, Warner B. A review of medication incidents reported to the national reporting and learning system in England and Wales over 6 years (2005-2010). Br J Clin Pharmacol. 2012;74(4):597-604.	Nonexperimental	526,186 medication incident reports.	n/a	n/a	Medication errors	Medication errors occur at all phases of the medication administration process and a multidisciplinary team should be created to assist with decreasing the errors and the information needs to be shared with those involved.	IIIB
7	Härkänen M, Turunen H, Vehviläinen-Julkunen K. Differences between methods of detecting medication errors: a secondary analysis of medication administration errors using incident reports, the global trigger tool method, and observations. J Patient Saf. March 24, 2016. Epub ahead of print.	Nonexperimental	Medication errors found on 671 incident reports, 153 global trigger tool results, and 235 observations.	n/a	n/a	Presence of medication errors	The three methods for error detection revealed different information on the medication errors, therefore the different methods should be combined. The researchers also recommend advanced multi-professional collaboration, effective communication, adequate skills, distraction-free work environments, and implementation of more systematic medication use processes.	IIIA
8	Grou Volpe CR, Moura Pinho DL, Morato Stival M, De Oliveira Karnikowski MG. Medication errors in a public hospital in Brazil. Br J Nurs. 2014;23(11):552-559.	Nonexperimental	484 medication administrations	n/a	n/a	Medication errors	Interdisciplinary committees should be established to help alleviate medication errors and nurses need additional periodic education on medication administration.	IIIB
9	Goldspiel B, Hoffman JM, Griffith NL, et al. ASHP guidelines on preventing medication errors with chemotherapy and biotherapy. Am J Health Syst Pharm. 2015;72(8):e6-e35.	Guideline	n/a	n/a	n/a	n/a	Evidence based guideline for preventing medication errors in patients receiving chemotherapy and biotherapy.	IVC
10	Anderson P, Townsend T. Preventing high alert medication errors in hospital patients. Am Nurse Today. 2015;10(5):18-23.	Expert Opinion	n/a	n/a	n/a	n/a	Medication prevention strategies include performing an independent double check, creating a multidisciplinary pharmacy and therapeutics committee, using a visual cue to decrease interruptions during medication administration, separated storage for sound-alike and look-alike medications, use tall man lettering for look-alike, sound alike or confusing named medications.	VC
11	ASHP guidelines: minimum standard for pharmacies in hospitals. Am J Health Syst Pharm. 2013;70(18):1619-1630.	Guideline	n/a	n/a	n/a	n/a	Consensus guideline for pharmacies.	IVC

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12	Sanchez SH, Sethi SS, Santos SL, Boockvar K. Implementing medication reconciliation from the planner's perspective: a qualitative study. BMC Health Serv Res. 2014;14:290.	Qualitative	13 people responsible for planning medication reconciliation processes.	n/a	n/a	What is needed to successfully implement a medication reconciliation system.	A multidisciplinary team and education are needed to implement a successful medication reconciliation process.	IIIB
13	Mandrack M, Cohen MR, Featherling J, et al. Nursing best practices using automated dispensing cabinets: nurses' key role in improving medication safety. Medsurg Nurs. 2012;21(3):134-144.	Expert Opinion	n/a	n/a	n/a	n/a	Education should be provided regarding use of automated drug dispensing cabinets and a multidisciplinary medication task force should make decisions regarding the automated drug dispensing system.	VB
14	Buxton JA, Babbitt R, Clegg CA, et al. ASHP guidelines: minimum standard for ambulatory care pharmacy practice. Am J Health Syst Pharm. 2015;72(14):1221-1236.	Guideline	n/a	n/a	n/a	n/a	Guidelines for the ambulatory care pharmacy.	IVB
15	Zhao RY, He XW, Shan YM, Zhu LL, Zhou Q. A stewardship intervention program for safe medication management and use of antidiabetic drugs. Clin Interv Aging. 2015;10:1201-1212.	Organizational Experience	In 2010-5,309 patients; 2011-6,315 patients; 2012-6,974 patients; 2013-7,375 patients.	n/a	n/a	Adverse drug events	Multidisciplinary collaboration resulted in a decrease in medication errors related to insulin use.	VA
16	Merry AF, Shipp DH, Lowinger JS. The contribution of labelling to safe medication administration in anaesthetic practice. Best Pract Res.Clin Anaesthesiol. 2011;25(2):145-159.	Expert Opinion	n/a	n/a	n/a	n/a	Medication syringes and containers should be labeled consistently, with tall man letters for look-alike medications, also tubing should be labeled.	VB
17	May SK, Park S. Risk factors and strategies for prevention of medication errors in patients with subarachnoid hemorrhage. Hosp Pharm. 2013;48(Suppl 5):S10-S20.	Literature Review	n/a	n/a	n/a	n/a	Multiple interventions are recommended based upon the literature reviewed for improving medication safety.	VB
18	Mankes RF, Silver CD. Quantitative study of controlled substance bedside wasting, disposal and evaluation of potential ecologic effects. Sci Total Environ. 2013;444:298-310.	Nonexperimental	Medications wasted at two facilities.	n/a	n/a	Numbers of medications wasted	Education on environmental impact of disposed medications may help to change prescribing practices. Multidisciplinary team should evaluate medication disposal practices.	IIIB

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19	ASHP guidelines on handling hazardous drugs. Am J Health Syst Pharm. 2006;63(12):1172-1193.	Guideline	n/a	n/a	n/a	n/a	The recommendations address the precautions to be taken when handling hazardous medications.	IVC
20	De Oliveira GSJ, Theilken LS, McCarthy RJ. Shortage of perioperative drugs: implications for anesthesia practice and patient safety. Anesth Analg. 2011;113(6):1429-1435.	Expert Opinion	n/a	n/a	n/a	n/a	Action plans for handling medication shortages should be in place.	VB
21	Golembiewski J. Drug shortages in the perioperative setting: causes, impact, and strategies. J Perianesth Nurs. 2012;27(4):286-292.	Expert Opinion	n/a	n/a	n/a	n/a	The facility should have an action plan to handle medication shortages.	VB
22	Engels MJ, Ciarkowski SL. Nursing, pharmacy, and prescriber knowledge and perceptions of high-alert medications in a large, academic medical hospital. Hosp Pharm. 2015;50(4):287-295.	Nonexperimental	465 nurses, 136 pharmacy personnel, 177 prescribers.	n/a	n/a	Knowledge, experience, and perceptions regarding high-alert medications.	Ongoing education on high-alert medications and the applicable risk reduction strategies is necessary to decrease knowledge gaps and to ensure individuals accept accountability in the medication use process.	IIIA
23	Centers for Medicare & Medicaid Services(CMS), DHHS. Medicare and Medicaid programs; hospital conditions of participation: requirements for history and physical examinations; authentication of verbal orders; securing medications; and postanesthesia evaluations. Final rule. Fed Regist. 2006;71(227):68671-68695.	Regulatory	n/a	n/a	n/a	n/a	Regulatory requirements for verbal orders, compounding, and securing medications.	n/a
24	Cohen MR, Smetzer JL. No unlabeled containers anywhere, ever! Where did this come from? Hosp Pharm. 2015;50(3):185-188.	Case Report	n/a	n/a	n/a	n/a	Label medications on the sterile field, use Tall man letters on labels, put medications on sterile field as close to time of use a s possible, verify medication when delivering to sterile field, discard all unlabeled solutions on sterile field.	VC
25	Erbe B. Safe medication administration in the operating room. Tar Heel Nurse. 2011;73(1):10-13.	Organizational Experience	15 cases with blank labels and 15 cases with preprinted labels.	Introductions of preprinted labels.	Labeling before and after introduction of preprinted labels.	n/a	Fewer inappropriate abbreviations were used with the preprinted labels compared to handwritten labels.	VB

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26	Bonkowski J, Carnes C, Melucci J, et al. Effect of barcode-assisted medication administration on emergency department medication errors. Acad Emerg Med. 2013;20(8):801-806.	Quasi-experimental	996 medication administrations before implementation, 982 after implementation in an emergency department at an academic medical center.	Implementation of a barcode-assisted medication administration system.	Before implementation of a barcode-assisted medication administration system.	Percentage of medication errors.	Emergency department drug errors were reduced after the introduction of the barcode-assisted medication administration system.	IIB
27	Bonkowski J, Weber RJ, Melucci J, Pesavento T, Henry M, Moffatt-Bruce S. Improving medication administration safety in solid organ transplant patients through barcode-assisted medication administration. Am J Med Qual. 2014;29(3):236-241.	Quasi-experimental	936 medication administrations before implementation, 976 after implementation in a solid organ transplant unit at an academic medical center.	Implementation of a barcode-assisted medication administration system.	Before implementation of a barcode-assisted medication administration system.	Medication errors	Solid organ transplant unit drug errors were reduced after the introduction of the barcode-assisted medication administration system.	IIB
28	Sethuraman U, Kannikeswaran N, Murray KP, Zidan MA, Chamberlain JM. Prescription errors before and after introduction of electronic medication alert system in a pediatric emergency department. Acad Emerg Med. 2015;22(6):714-719.	Nonexperimental	7,268 orders before, 7,292 orders after.	Electronic prescription order entry system	Paper-based order entry system.	Order entry errors.	Prescription errors decreased with the use of computerized prescriber order entry system.	IIIB
29	Ching JM, Williams BL, Idemoto LM, Blackmore CC. Using lean "automation with a human touch" to improve medication safety: a step closer to the "perfect dose." Jt Comm J Qual Patient Saf. 2014;40(8):341-350.	Quasi-experimental	Patients admitted from 2010 -2012.	Implementation of a barcode medication administration system.	No barcode medication administration system.	Medication errors	Medication errors decreased after implementation of a barcode medication administration system.	IIB
30	Armada ER, Villamanan E, Lopez-de-Sa E, et al. Computerized physician order entry in the cardiac intensive care unit: effects on prescription errors and workflow conditions. J Crit Care. 2014;29(2):188-193.	Nonexperimental	158 treatment order using paper entry, 142 computerized entry.	Computerized prescriber order entry	Paper based ordering system	Medication errors	Medication errors decreased after implementation of a computerized prescriber order entry system, education should be provided on the use of the system, and errors should be reviewed.	IIIB

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31	Allison GM, Weigel B, Holcroft C. Does electronic medication reconciliation at hospital discharge decrease prescription medication errors? Int J Health Care Qual Assur. 2015;28(6):564-573.	Nonexperimental	100 patients pre and post implementation.	n/a	n/a	Medication errors	Medication errors decreased with the use of an electronic medication reconciliation tool.	IIIB
32	Charles K, Cannon M, Hall R, Coustasse A. Can utilizing a computerized provider order entry (CPOE) system prevent hospital medical errors and adverse drug events? Perspect Health Inf Manag. 2014;11:1b.	Systematic review	n/a	n/a	n/a	n/a	The use of computerized provider order entry systems helps to decrease medication errors.	IIB
33	Connor AJ, Hutton P, Severn P, Masri I. Electronic prescribing and prescription design in ophthalmic practice. Eur J Ophthalmol. 2011;21(5):644-648.	Qualitative	100 prescriptions from each day surgery, ophthalmology, and 50 discharge prescriptions.	n/a	n/a	Presence of all components of the prescriptions.	Computerized provider order entry should be used or at least use paper forms with prompts.	IIIB
34	Fischer JR. The impact of health care technology on medication safety. S D Med. 2014;67(7):279-280.	Literature Review	n/a	n/a	n/a	n/a	The use of electronic medication administration records, barcode technology, computerized provider order entry, and clinical decision support systems decreased the rates of medication errors but the reduction in the rate of errors is not linked to the degree or amount of patient harm and further research is needed in this area.	VC
35	Green RA, Hripcsak G, Salmasian H, et al. Intercepting wrong-patient orders in a computerized provider order entry system. Ann Emerg Med. 2015;65(6):679-686.	Quasi-experimental	3,457,342 electronic orders	Implementation of a computerized order entry system.	No computerized provider order entry system.	Wrong-patient orders	Wrong-patient medication errors decreased with the implementation of a computerized provider order entry system.	IIB
36	Henneman PL, Marquard JL, Fisher DL, et al. Bar-code verification: reducing but not eliminating medication errors. J Nurs Adm. 2012;42(12):562-566.	Nonexperimental	25 emergency room nurses	n/a	n/a	Scenario based identification of medication errors.	Medication errors are decreased, but not eliminated by the use of a bar-code system.	IIIB

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37	Hernandez F, Majoul E, Montes-Palacios C, et al. An observational study of the impact of a computerized physician order entry system on the rate of medication errors in an orthopaedic surgery unit. PLoS One. 2015;10(7):e0134101.	Quasi-experimental	1,593 prescriptions pre, 1,388 prescriptions post.	Implementation of an computerized prescriber order entry system.	Paper based ordering system.	Medication errors	The number of medication errors decreased following the implementation of a computerized prescriber order entry system.	IIB
38	Hassink JJM, Jansen MMPM, Helmons PJ. Effects of bar code-assisted medication administration (BCMA) on frequency, type and severity of medication administration errors: a review of the literature. Eur J Hosp Pharm Sci Pract. 2012;19(5):489-494.	Literature Review	n/a	n/a	n/a	n/a	Barcode-assisted medication administration systems help to reduce medication errors.	VB
39	Khammarnia M, Kassani A, Eslahi M. The efficacy of patients' wristband bar-code on prevention of medical errors: a meta-analysis study. Appl Clin Inform. 2015;6(4):716-727.	Systematic Review w/ Meta-Analysis	14 articles	n/a	n/a	Effectiveness of wristband bar-code medication scanning.	Use of an unique patient identification barcode system will help to reduce medication errors.	IIA
40	Leung AA, Schiff G, Keohane C, et al. Impact of vendor computerized physician order entry on patients with renal impairment in community hospitals. J Hosp Med. 2013;8(10):545-552.	Quasi-experimental	775 patients pre, 815 patients post.	Application of Clinical decision support.	No clinical decision support	Rates of preventable, overall , and potential adverse drug events.	Computerized physician order entry with advanced clinical decision support can reduce the number of preventable adverse drug events.	IIB
41	Manias E, Kinney S, Cranswick N, Williams A, Borrott N. Interventions to reduce medication errors in pediatric intensive care. Ann Pharmacother. 2014;48(10):1313-1331.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	The use of computerized prescriber order entry with computerized decision support decreased medication error rates in a pediatric ICU.	IIIA

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42	Nuckols TK, Smith-Spangler C, Morton SC, et al. The effectiveness of computerized order entry at reducing preventable adverse drug events and medication errors in hospital settings: a systematic review and meta-analysis. Syst Rev. 2014;3:56.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	The use of computerized provider order entry systems reduces medication errors.	IIIA
43	Roberts DL, Noble B, Wright MJ, Nelson EA, Shaft JD, Rakela J. Impact of computerized provider order entry on hospital medication errors. J Clin Outcomes Manag. 2013;20(3):109-115.	Quasi-experimental	Patients admitted to facility from November 6,2006 to May 7,2007. No sample size provided.	Application of computerized order entry system.	n/a	Medication errors	The use of computerized prescriber order entry decreased medication error rates.	IIA
44	Sanchez Cuervo M, Rojo Sanchis A, Pueyo Lopez C, Gomez De Salazar Lopez De Silanes E, Gramage Caro T, Bermejo Vicedo T. The impact of a computerized physician order entry system on medical errors with antineoplastic drugs 5 years after its implementation. J Clin Pharm Ther. 2015;40(5):550-554.	Quasi-experimental	150 prescription pre and post.	5 years after implementing a computerized provider order entry system.	Before implementing the system.	Medication errors	Medication errors continued to be less 5 years after implementing a computerized provider order entry system.	IIA
45	Shawahna R, Rahman N, Ahmad M, Debray M, Yliperttula M, Decleves X. Electronic prescribing reduces prescribing error in public hospitals. J Clin Nurs. 2011;20(21-22):3233-3245.	Quasi-experimental	13,328 prescriptions pre, 14,064 prescriptions post.	Electronic prescribing	Paper prescribing	Prescribing errors	Use of electronic prescribing decreased the number of prescribing errors.	IIB
46	Truitt E, Thompson R, Blazey-Martin D, NiSai D, Salem D. Effect of the implementation of barcode technology and an electronic medication administration record on adverse drug events. Hosp Pharm. 2016;51(6):474-483.	Quasi-experimental	397 pre-implementation errors and 378 post-implementation errors. Errors used occurred within 5 months before or after implementation.	Implementation of a electronic medication administration record and barcode medication administration.	Medication errors pre- and post-implementation of an electronic medication administration record and barcode medication administration.	Number of adverse drug events and severity level of administration errors.	Adverse drug events and transcription errors decreased in the five months after implementation of bar code technology. The mean severity level of the administration errors also decreased.	IIB

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47	Westbrook JI, Li L, Georgiou A, Paoloni R, Cullen J. Impact of an electronic medication management system on hospital doctors' and nurses' work: a controlled pre-post, time and motion study. J Am Med Inform Assoc. 2013;20(6):1150-1158.	Nonexperimental	129 nurses and physicians	n/a	n/a	Medication errors	Medication errors were decreased when an electronic medication management system was introduced and patient care time was not changed.	IIIB
48	Jozefczyk KG, Kennedy WK, Lin MJ, et al. Computerized prescriber order entry and opportunities for medication errors: comparison to tradition paper-based order entry. J Pharm Pract. 2013;26(4):434-437.	Quasi-experimental	500 orders in both the pre and post implementation groups.	Implementation of an computerized prescriber order entry system.	Pre-implementation	Number of opportunities for error.	The opportunities for error decreased after the implementation of a computerized prescriber order entry system.	IIB
49	Buus A, Nyvang L, Heiden S, Pape-Haugaard L. Quality assurance and effectiveness of the medication process through tablet computers? Stud Health Technol Inform. 2012;180:348-352.	Qualitative	Observation phase: Three nurses for two days of medication administrations. Structured workshop phase: seven health care professionals. Qualitative interviews: two nurses and two experts.	n/a	n/a	Impact of tablet computers on medication dispensing and administration.	Use of technology has the potential to improve patient safety but needs continuous updates to remain effective.	IIIB
50	McComas J, Riingen M, Chae Kim S. Impact of an electronic medication administration record on medication administration efficiency and errors. Comput Inform Nurs. 2014;32(12):589-595.	Nonexperimental	78 medication administration activities pre, 78 medication administration activities post	Implementation of a electronic medication administration record	Manual documentation	Medication errors	Medication errors decreased after implementation of the electronic medication administration record.	IIIB
51	Seibert HH, Maddox RR, Flynn EA, Williams CK. Effect of barcode technology with electronic medication administration record on medication accuracy rates. Am J Health Syst Pharm. 2014;71(3):209-218.	Quasi-experimental	Facility 1: 2092 medication administrations prior to and 1577 administrations after. Facility 2: 2061 medication administrations before and 773 after. Multiple units were studied at both facilities.	Implementation of a barcode medication administration system.	Pre and post implementation of a barcode-assisted medication administration system.	Medication errors	The medication accuracy rate improved significantly with the use of a barcode-assisted medication administration system.	IIA

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52	Dwibedi N, Sansgiry SS, Frost CP, et al. Bedside barcode technology: impact on medication administration tasks in an intensive care unit. Hosp Pharm. 2012;47(5):360-366.	Nonexperimental	101 paper-based medication administrations and 151 bedside barcode medication administrations in an ICU setting.	n/a	Pre and post implementation of a bedside barcode medication administration system.	Medication administration time	During bar code medication administration the time spent by nurses on administering medications and documenting medications was significantly reduced, and the time conversing with patients was increased.	IIIB
53	Abbass I, Mhatre S, Sansgiry SS, Tipton J, Frost C. Impact and determinants of commercial computerized prescriber order entry on the medication administration process. Hosp Pharm. 2011;46(5):341-348.	Nonexperimental	563 paper-based orders, 547 computer based orders	n/a	n/a	Medication errors and turnaround time.	Use of a computerized prescribing system reduced errors and medication turnaround times.	IIIA
54	Stroud D. Preventing medication administration errors: lockable, computerized medication administration carts help hospitals avoid errors and reduce costs. Health Manag Technol. 2013;34(11):18-19.	Organizational Experience	N/a	n/a	n/a	n/a	The implementation of computerized medication administration carts decreased the amount of medications administered late and resulted in reduced costs related to wasted medications.	VC
55	Aziz MT, Ur-Rehman T, Qureshi S, Bukhari NI. Reduction in chemotherapy order errors with computerised physician order entry and clinical decision support systems. HIM J. 2015;44(3):13-22.	Nonexperimental	5514 and 3765 chemotherapy protocol orders.	Computerized ordering system	Paper based ordering system	Medication errors	Medication errors decreased after implementation of a computerized prescriber order entry system and it also assisted with decrease in severity of errors, improvements in dispensing and prescribing times and a reduction in costs.	IIIB
56	Maat B, Rademaker CMA, Oostveen MI, Krediet TG, Egberts TCG, Bollen CW. The effect of a computerized prescribing and calculating system on hypo- and hyperglycemias and on prescribing time efficiency in neonatal intensive care patients. JPEN J Parenter Enteral Nutr. 2013;37(1):85-91.	Quasi-experimental	Seven physicians	Initiation of a computerized physician order entry system	No computerized physician order entry system	Length of prescribing time	The time taken to prescribe insulin in enteral and parenteral nutrition was less when using the computerized prescribing system.	IIB
57	Hollister DJ, Messenger A. Implementation of computerized physician order entry at a community hospital. Conn Med. 2011;75(4):227-233.	Organizational Experience	184,474 prescriptions pre, 240,456 post.	Implementation of a computerized prescriber order entry system.	n/a	Medication errors, verification time and number of illegible signatures.	The use of a computerized prescriber order entry system reduced the number of medication errors, shortened pharmacy verification time and improved identification of ordering physicians.	VB

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58	Morley C, McLeod E, McKenzie D, et al. Reducing dose omission of prescribed medications in the hospital setting: a narrative review. Drugs Ther Perspect. 2016;32(5):203-208.	Literature Review	n/a	n/a	n/a	n/a	Measures to prevent medication errors include education, clear multidisciplinary communication between all parties involved in the medication process, use of computerized order entry, and changing pharmacy processes to be certain medication is available.	VB
59	Hartel MJ, Staub LP, Roder C, Eggli S. High incidence of medication documentation errors in a Swiss university hospital due to the handwritten prescription process. BMC Health Serv Res. 2011;11:199.	Nonexperimental	1,934 prescriptions	n/a	n/a	Legibility of prescription and documentation / transcription errors.	A computerized order entry system should be used instead of hand written prescription because many hand written contain errors and are not legible.	IIIB
60	Albarrak AI, Al Rashidi EA, Fatani RK, Al Ageel SI, Mohammed R. Assessment of legibility and completeness of handwritten and electronic prescriptions. Saudi Pharm J. 2014;22(6):522-527.	RCT	199 handwritten and 199 computerized prescriptions	Computerized prescribing system	Handwritten prescribing	Incomplete or illegible prescriptions	The use of computerized provider order entry systems resulted in a decrease in illegible and incomplete prescriptions.	IB
61	Abramson EL, Barron Y, Quaresimo J, Kaushal R. Electronic prescribing within an electronic health record reduces ambulatory prescribing errors. Jt Comm J Qual Patient Saf. 2011;37(10):470-478.	Quasi-experimental	2,432 prescriptions pre, 2,079 prescriptions post.	Implementation of computerized prescriber order entry system.	No computerized prescriber order entry system.	Prescribing errors	Use of computerized physician order entry systems decreases ambulatory prescribing errors.	IIB
62	Meisenberg BR, Wright RR, Brady-Copertino CJ. Reduction in chemotherapy order errors with computerized physician order entry. J Oncol Pract. 2014;10(1):e5-e9.	Organizational Experience	2.216 handwritten, 2,480 preprinted, 5,142 computerized orders.	n/a	n/a	n/a	Pre-printed orders contained fewer errors than handwritten orders and orders entered on a computerized prescriber order entry system contained even fewer orders.	VA
63	Al-Rowibah FA, Younis MZ, Parkash J. The impact of computerized physician order entry on medication errors and adverse drug events. J Health Care Finance. 2013;40(1):93-102.	Nonexperimental	93 physicians	n/a	n/a	Medication error	The physicians who responded to the survey believed the computerized order entry decreased the number of medication errors when compared to hand-written prescriptions.	IIIB

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64	Fanning L, Jones N, Manias E. Impact of automated dispensing cabinets on medication selection and preparation error rates in an emergency department: a prospective and direct observational before-and-after study. J Eval Clin Pract. 2016;22(2):156-163.	Nonexperimental	1139 medication selections and preparations pre, 864 post implementation	Implementation of automated drug dispensing system	Use of medication storage room	Medication preparation and selection errors	Use of automated dispensing cabinets has been shown to decrease the number of medication selection and preparation errors.	IIIB
65	Cochran GL, Barrett RS, Horn SD. Comparison of medication safety systems in critical access hospitals: combined analysis of two studies. Am J Health Syst Pharm. 2016;73(15):1167-1173.	Nonexperimental	2955 onsite pharmacist, 3031 tele pharmacist.	n/a	n/a	Medication error rates	Medication errors are reduced with the use of a barcode medication system and with the use of an on site pharmacist.	IIIA
66	Tsao NW, Lo C, Babich M, Shah K, Bansback NJ. Decentralized automated dispensing devices: systematic review of clinical and economic impacts in hospitals. Can J Hosp Pharm. 2014;67(2):138-148.	Systematic review	n/a	n/a	n/a	n/a	Automated drug dispensing units may decrease medication errors and increase efficiency.	IIIB
67	Turchin A, Shubina M, Goldberg S. Unexpected effects of unintended consequences: EMR prescription discrepancies and hemorrhage in patients on warfarin. AMIA Annu Symp Proc. 2011;2011:1412-1417.	Nonexperimental	573 patients on warfarin with hemorrhage, 1719 controls.	n/a	n/a	Presence of an internal discrepancy in the electronic warfarin prescription.	Consequences of errors using CPOE may not be obvious and internal discrepancies are an error that occurs only with CPOE.	IIIB
68	Sparnon E. Spotlight on electronic health record errors: errors related to the use of default values. Penn Patient Saf Advis. 2013;10(3):92-95.	Nonexperimental	324 reports	n/a	n/a	Cause of error	Failure to change a default value was the most common reported cause of error.	IIIB
69	Rodriguez-Gonzalez CG, Herranz-Alonso A, Martin-Barbero ML, et al. Prevalence of medication administration errors in two medical units with automated prescription and dispensing. J Am Med Inform Assoc. 2012;19(1):72-78.	Nonexperimental	2314 medication administrations	n/a	n/a	Frequency of medication errors with the use of a computerized order entry system.	Medication errors continue to exist in units using computerized order entry systems and nurses were lacking knowledge about medications.	IIIB

REFERENCE #	CITATION	EVIDENCE TYPE	SAMPLE SIZE/ POPULATION	INTERVENTION(S)	CONTROL/ COMPARISON	OUTCOME MEASURE(S)	CONCLUSION(S)	CONSENSUS SCORE
70	Stultz JS, Nahata MC. Preventability of voluntarily reported or trigger tool-identified medication errors in a pediatric institution by information technology: a retrospective cohort study. Drug Saf. 2015;38(7):661-670.	Nonexperimental	1649 medication error reports	n/a	n/a	Phase error occurred and if preventable by electronic medication ordering system.	Some medication errors that occur during use of an electronic medication ordering system may be preventable by correct use of the information technology and others are not.	IIIB
71	Wetterneck TB, Walker JM, Blosky MA, et al. Factors contributing to an increase in duplicate medication order errors after CPOE implementation. J Am Med Inform Assoc. 2011;18(6):774-782.	Nonexperimental	4147 patient days pre, 4013 patient days post	Implementation of a computerized order entry system.	No computerized order entry system.	Duplicate medication orders	Duplicate medication errors increased after implementation of a computerized order entry system.	IIIB
72	Van Der Sijs H, Rootjes I, Aarts J. The shift in workarounds upon implementation of computerized physician order entry. Stud Health Technol Inform. 2011;169:290-294.	Qualitative	A resident, medical specialist, senior nurse, second nurse, and pharmacist on two units one with electronic ordering and one with paper ordering.	n/a	n/a	Workarounds	Work arounds exist in both paper and electronic prescribing systems.	IIIB
73	Joy A, Davis J, Cardona J. Effect of computerized provider order entry on rate of medication errors in a community hospital setting. Hosp Pharm. 2012;47(9):693-699.	Organizational Experience	13,791 medication orders pre, 35,029 medication orders post.	Implementation of computerized prescription system.	Paper based prescription ordering.	n/a	Use of a computerized prescribing system reduced medication errors.	VA
74	Nelson CE, Selbst SM. Electronic prescription writing errors in the pediatric emergency department. Pediatr Emerg Care. 2015;31(5):368-372.	Nonexperimental	350 prescriptions	n/a	n/a	Medication errors	Medication errors including clinically significant errors continued after the implementation of computerized prescription order entry.	IIIA
75	Schwartzberg D, Ivanovic S, Patel S, Burjonrappa SC. We thought we would be perfect: medication errors before and after the initiation of computerized physician order entry. J Surg Res. 2015;198(1):108-114.	Quasi-experimental	1,280,606 orders pre and 2,089,632 orders post implementation	Electronic prescription order entry system	Paper-based order entry system.	Order entry errors.	Medication order errors continue after implementation of an electronic order entry system.	IIB

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76	Naunton M, Gardiner HR, Kyle G. Look-alike, sound-alike medication errors: a novel case concerning a Slow-Na, Slow-K prescribing error. Int Med Case Rep J. 2015;8:51-53.	Case Report	n/a	n/a	n/a	n/a	Case report describing a situation in which a prescriber selected the wrong medication from a list of medications both of which began with "Slow".	VC
77	Cohen MR, Smetzer JL. ISMP medication error report analysis—tretinoin confused with isotretinoin; death from intravenous nimodipine; incorrect medication names selected during order entry; reduce Ambien dose in order sets; confusion between levothyroxine and liothyronine. Hosp Pharm. 2013;48(6):455-457.	Case Report	n/a	n/a	n/a	n/a	Case report describing medication errors related to selecting the wrong medication in a computerized provider order entry system, name confusion, and medication given via the wrong route.	VC
78	Maat B, Au YS, Bollen CW, van Vught AJ, Egberts TCG, Rademaker CMA. Clinical pharmacy interventions in paediatric electronic prescriptions. Arch Dis Child. 2013;98(3):222-227.	Nonexperimental	1577 cases, 1983 controls	n/a	n/a	Frequency of clinical pharmacy interventions.	Prescribing errors continue to occur even after implementation of a computerized prescriber order entry system especially when the name is inserted using free text.	IIIA
79	Tully MP. Prescribing errors in hospital practice. Br J Clin Pharmacol. 2012;74(4):668-675.	Literature Review	n/a	n/a	n/a	n/a	More research needs to occur using similar definitions, most errors are multifactorial, CPOE may decrease some errors but others are created.	VB
80	Villamanan E, Larrubia Y, Ruano M, et al. Potential medication errors associated with computer prescriber order entry. Int J Clin Pharm. 2013;35(4):577-583.	Nonexperimental	85,857 prescriptions	n/a	n/a	Medication errors	Medication errors are decreased with the use of computerized prescriber order entry but there are new errors that are directly attributed to the computerized order entry system.	IIIB
81	Warrick C, Naik H, Avis S, Fletcher P, Franklin BD, Inwald D. A clinical information system reduces medication errors in paediatric intensive care. Intensive Care Med. 2011;37(4):691-694.	Quasi-experimental	528 prescriptions pre, 216 post phase 1, 278 post phase 2.	Implementation of a computerized prescriber order entry system.	No computerized prescriber order entry system.	Medication errors	Electronic prescribing decreased some errors but introduced some new types of errors.	IIB

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82	Gimenes FRE, Marques TC, Teixeira TCA, Mota MLS, Silva AE, Cassiani SH. Medication wrong-route administrations in relation to medical prescriptions. Rev Lat Am Enfermagem. 2011;19(1):11-17.	Nonexperimental	1,425 situations of disagreement between the way the medication was administered and the prescription.	n/a	n/a	Discrepancy between the method the medication was administered and the prescription.	The use of abbreviations lead to medications being administered via the wrong route, even with the use of an electronic order entry system that allows for the use of abbreviations and acronyms. The use of abbreviations was related to the lack of knowledge about the ramifications of abbreviations use.	IIIB
83	Redwood S, Rajakumar A, Hodson J, Coleman JJ. Does the implementation of an electronic prescribing system create unintended medication errors? A study of the sociotechnical context through the analysis of reported medication incidents. BMC Med Inform Decis Mak. 2011;11:29.	Nonexperimental	485 incidents	n/a	n/a	Incidents related to computerized order entry	New types of medication errors are created when computerized prescriber order entry is implemented.	IIIB
84	Westbrook JI, Reckmann M, Li L, et al. Effects of two commercial electronic prescribing systems on prescribing error rates in hospital in-patients: a before and after study. PLoS Med. 2012;9(1):e1001164.	Quasi-experimental	1,923 prescriptions pre, 1,368 post .	Implementation of a computerized prescriber order entry system.	No computerized prescriber order entry system.	Medication errors	Electronic prescribing decreased some errors but introduced some new types of errors.	IIA
85	Hinojosa-Amaya JM, Rodríguez-Garcia FG, Yeverino-Castro SG, Sánchez-Cárdenas M, Villarreal-Alarcón MÁ, Galarza-Delgado DÁ. Medication errors: electronic vs. paper-based prescribing. Experience at a tertiary care university hospital. J Eval Clin Pract. 2016;22(5):751-754.	Quasi-experimental	301 medical records pre, 300 medical records post.	Implementation of an computerized prescriber order entry system.	Paper based ordering system.	Number of medication errors and ranking on a severity index.	The number of medication errors decreased after implementation of a computerized prescriber order entry system but the severity of the errors increased.	IIA
86	Electronic prescribing: the risk of errors and adverse effects. Prescrire Int. 2016;25(167):24-27.	Literature Review	n/a	n/a	n/a	n/a	Several types of medication errors have been reported even with the use of computerized prescriber order entry systems, some of which did not exist prior to the introduction of computerized order entry systems.	VB
87	Leung AA, Keohane C, Amato M, et al. Impact of vendor computerized physician order entry in community hospitals. J Gen Intern Med. 2012;27(7):801-807.	Quasi-experimental	1,000 medical records before and 1,000 records after implementation.	Implementation of a computerized prescriber order entry system.	No computerized provider order entry system used.	Adverse drug event	The number of preventable adverse drug events decreased but the number of potential adverse drug events actually increased.	IIB

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88	Hoonakker PLT, Carayon P, Walker JM, Brown RL, Cartmill RS. The effects of computerized provider order entry implementation on communication in intensive care units. Int J Med Inform. 2013;82(5):e107-e117.	Nonexperimental	267 nurses and providers	n/a	n/a	Quality of communication	Implementation of a computerized order entry system has a negative effect on communication for the short term but it returns to normal in the long term.	IIIB
89	Tschannen D, Talsma A, Reinemeyer N, Belt C, Schoville R. Nursing medication administration and workflow using computerized physician order entry. Comput Inform Nurs. 2011;29(7):401-410.	Nonexperimental	50 observations from ICU, 36 observations from Pediatrics.	n/a	n/a	Alterations in workflow	The nursing workflow pattern was altered when the computerized prescriber order entry system was introduced which may lead to more medication errors.	IIIB
90	Samaranayake NR, Cheung DST, Lam MPS, et al. The effectiveness of a “do not use” list and perceptions of healthcare professionals on error-prone abbreviations. Int J Clin Pharm. 2014;36(5):1000-1006.	Organizational Experience	1,028 pre implementation. 1,134 Phase 1 post, 1,076 Phase 2 post.	Implementation of a "Do Not Use" abbreviation list	No "Do Not Use" list	Use of risky abbreviations	A "Do not use" abbreviation list is beneficial but continual education on abbreviations is warranted.	VB
91	Samaranayake NR, Dabare PRL, Wanigatunge CA, Cheung BMY. The pattern of abbreviation use in prescriptions: a way forward in eliminating error-prone abbreviations and standardisation of prescriptions. Curr Drug Saf. 2014;9(1):34-42.	Nonexperimental	989 prescriptions	n/a	n/a	Unapproved abbreviations.	Several abbreviations identified as error prone were used in prescriptions and a "Do not use" list should be developed and education provided.	IIIB
92	Flannery AH, Parli SE. Medication errors in cardiopulmonary arrest and code-related situations. Am J Crit Care. 2016;25(1):12-20.	Expert Opinion	n/a	n/a	n/a	n/a	The multidisciplinary team should review and approve drug references.	VB

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93	Thomas AN, Taylor RJ. An analysis of patient safety incidents associated with medications reported from critical care units in the north west of England between 2009 and 2012. Anaesthesia. 2014;69(7):735-745.	Nonexperimental	2238 incident reports	n/a	n/a	Reasons for medication errors	Current information about medications should be available to those administering the medications.	IIIB
94	Alex S, Adenew AB, Arundel C, Maron DD, Kerns JC. Medication errors despite using electronic health records: the value of a clinical pharmacist service in reducing discharge-related medication errors. Qual Manag Health Care. 2016;25(1):32-37.	Organizational Experience	Control 134 patients, Intervention 145 patients, admitted under the care of one of two medicine teams.	Clinical pharmacist assistance	No clinical pharmacist assistance	Medication discrepancies at discharge.	Assistance from a clinical pharmacist can decrease medication discrepancies at discharge.	VA
95	Abbasinazari M, Hajhossein Talasaz A, Eshraghi A, Sahraei Z. Detection and management of medication errors in internal wards of a teaching hospital by clinical pharmacists. Acta Med Iran. 2013;51(7):482-486.	Nonexperimental	132 patients admitted to two units in an Iranian hospital.	n/a	n/a	Medication errors found by pharmacist	Involvement of a pharmacist can decrease the number of medication errors.	IIIA
96	Cesarz JL, Steffenhagen AL, Svenson J, Hamedani AG. Emergency department discharge prescription interventions by emergency medicine pharmacists. Ann Emerg Med. 2013;61(2):209-214.	Nonexperimental	674 discharge prescriptions	n/a	n/a	Pharmacist interventions on discharge prescriptions	Pharmacist review of prescriptions decreased the suboptimal prescriptions and is valued by ED care providers	IIIB
97	Ernst AA, Weiss SJ, Sullivan A4, et al. On-site pharmacists in the ED improve medical errors. Am J Emerg Med. 2012;30(5):717-725.	Nonexperimental	452 patients pre, 242 patients post	Presence of a pharmacist	Pharmacist not present	Medication errors found by pharmacist	A pharmacist in the ED may reduce medication errors.	IIIB
98	Ho L, Akada K, Messner H, Kuruvilla J, Wright J, Seki JT. Pharmacist's role in improving medication safety for patients in an allogeneic hematopoietic cell transplant ambulatory clinic. Can J Hosp Pharm. 2013;66(2):110-117.	Organizational Experience	35 patients, 100 visits to clinic	n/a	n/a	Number of medication discrepancies.	Medication reconciliation performed by a pharmacist identified medication discrepancies thereby improving medication safety.	VA

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99	Jiang S, Zheng X, Li X, Lu X. Effectiveness of pharmaceutical care in an intensive care unit from china. A pre- and post-intervention study. Saudi Med J. 2012;33(7):756-762.	Nonexperimental	409 patients pre, 416 patients post	Presence of a pharmacist	No pharmacist involvement	Number of medication errors and cost savings.	The interventions performed by a pharmacist in the ICU prevented medication errors and decreased cost.	IIIB
100	Jiang SP, Zhu ZY, Wu XL, Lu XY, Zhang XG, Wu BH. Effectiveness of pharmacist dosing adjustment for critically ill patients receiving continuous renal replacement therapy: a comparative study. Ther Clin Risk Manag. 2014;10:405-412.	Nonexperimental	103 patients pre, 106 patients post.	Presence of a pharmacist	No pharmacist involvement	Number of dosing adjustments	The interventions performed by a pharmacist in the ICU prevented medication errors.	IIIB
101	Mergenhagen KA, Blum SS, Kugler A, et al. Pharmacist- versus physician-initiated admission medication reconciliation: impact on adverse drug events. Am J Geriatr Pharmacother. 2012;10(4):242-250.	Quasi-experimental	102 admissions pharmacist, 116 admissions physician.	Pharmacist completed medication reconciliation.	Physician completed medication reconciliation.	Prescribing errors	Pharmacist completed reconciliation was more comprehensive and had lower odds of prescribing errors than physician completed medication reconciliation.	IIB
102	ASHP statement on the pharmacist's role in medication reconciliation. Am J Health Syst Pharm. 2013;70(5):453-456.	Guideline	n/a	n/a	n/a	n/a	Guideline which describes the pharmacist role in medication reconciliation.	IVC
103	Phatak A, Prusi R, Ward B, et al. Impact of pharmacist involvement in the transitional care of high-risk patients through medication reconciliation, medication education, and postdischarge call-backs (IPITCH Study). J Hosp Med. 2016;11(1):39-44.	RCT	141 patients in control group, 137 patients in study group	Pharmacist involvement in medication reconciliation, education and post discharge follow-up.	No pharmacy involvement	Readmission or ED visits, adverse drug events, medication errors, HCAHPS scores.	Readmission rates, ED visits, medication errors, and adverse drug events decreased. HCAPHPS scores increased with pharmacist involvement.	IB
104	Lenssen R, Heidenreich A, Schulz JB, et al. Analysis of drug-related problems in three departments of a German university hospital. Int J Clin Pharm. 2016;38(1):119-126.	Nonexperimental	306 patients admitted to three different units in a German hospital.	n/a	n/a	Drug-related problems	A pharmacist can identify potential drug related problems and may be an option to address the issue of medication errors.	IIIB

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105	Ibanez-Garcia S, Rodriguez-Gonzalez CG, Martin-Barbero ML, Sanjurjo-Saez M, Herranz-Alonso A; iPharma. Adding value through pharmacy validation: a safety and cost perspective. J Eval Clin Pract. 2016;22(2):253-260.	Nonexperimental	Six pharmacists	n/a	n/a	Number of pharmacist interventions and the estimated cost of the error if no intervention present.	Pharmacy validation of medication orders decreases potential medication errors and has a cost benefit.	IIIB
106	Fernandez-Llamazares CM, Calleja-Hernandez M, Manrique-Rodriguez S, Perez-Sanz C, Duran-Garcia E, Sanjurjo-Saez M. Prescribing errors intercepted by clinical pharmacists in paediatrics and obstetrics in a tertiary hospital in Spain. Eur J Clin Pharmacol. 2012;68(9):1339-1345.	Nonexperimental	61,458 orders on pediatric patients and 119,333 orders on adult patients.	n/a	n/a	Interventions by pharmacy	Interventions by a pharmacist assisted in decreasing medication errors.	IIIA
107	Zaal RJ, Jansen MMPM, Duisenberg-van Essenberg M, Tijssen CC, Roukema JA, van den Bemt PMLA. Identification of drug-related problems by a clinical pharmacist in addition to computerized alerts. Int J Clin Pharm. 2013;35(5):753-762.	Nonexperimental	1206 prescriptions	n/a	n/a	Drug related problems	More drug related problems were detected by a clinical pharmacist than by the computerized prescriber order entry system alerts.	IIIB
108	Kuo GM, Touchette DR, Marinac JS. Drug errors and related interventions reported by United States clinical pharmacists: the American College of Clinical Pharmacy practice-based research network medication error detection, amelioration and prevention study. Pharmacotherapy. 2013;33(3):253-265.	Nonexperimental	676 pharmacists	n/a	n/a	Results of pharmacists interventions.	Medication errors were caught by the pharmacist prior to reaching the patient.	IIIB

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109	Caroff DA, Bittermann T, Leonard CE, Gibson GA, Myers JS. A medical resident-pharmacist collaboration improves the rate of medication reconciliation verification at discharge. Jt Comm J Qual Patient Saf. 2015;41(10):457-461.	Quasi-experimental	981 discharges pre, 1,207 discharges post.	Pharmacist reconciliation	Resident reconciliation	Medication reconciliation discrepancies.	The identification of errors during discharge reconciliation improved when the reconciliation was performed by a pharmacist compared to the reconciliation being performed by the resident.	IIA
110	Graabaek T, Kjeldsen LJ. Medication reviews by clinical pharmacists at hospitals lead to improved patient outcomes: a systematic review. Basic Clin Pharmacol Toxicol. 2013;112(6):359-373.	Systematic Review	n/a	n/a	n/a	n/a	The implementation of a clinical pharmacy service assists with reducing medication errors.	IIIB
111	Han J, Ah Y, Suh SY, et al. Clinical and economic impact of pharmacists' intervention in a large volume chemotherapy preparation unit. Int J Clin Pharm. 2016;38(5):1124-1132.	Nonexperimental	435 patients	n/a	n/a	Pharmacy interventions	The involvement of a pharmacist decreased medication errors and had a positive economic impact.	IIIB
112	Khalili H, Farsaei S, Rezaee H, Dashti-Khavidaki S. Role of clinical pharmacists' interventions in detection and prevention of medication errors in a medical ward. Int J Clin Pharm. 2011;33(2):281-284.	Nonexperimental	861 patients	n/a	n/a	Potential medication errors	The clinical pharmacist prevented medication errors by detecting prescribing errors including wrong dose, wrong medication, wrong indication and potential interactions.	IIIB
113	Hohmann C, Neumann-Haefelin T, Klotz JM, Freidank A, Radziwill R. Drug-related problems in patients with ischemic stroke in hospital. Int J Clin Pharm. 2012;34(6):828-831.	Nonexperimental	155 patients diagnosed with an ischemic stroke and were, taking more than two medications on admission and discharge	n/a	n/a	Drug related problems	Drug related problems occur during any phase of the process and the clinical pharmacist can identify and resolve drug related problems in this population.	IIIB

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114	Galvin M, Jago-Byrne M, Fitzsimons M, Grimes T. Clinical pharmacist's contribution to medication reconciliation on admission to hospital in Ireland. Int J Clin Pharm. 2013;35(1):14-21.	Nonexperimental	1556 medication orders from 134 patients who were at least 18 years of age, taking at least 3 medications, and were admitted to two acute teaching hospitals in Ireland.	n/a	n/a	Frequency of pharmacist's activities, frequency and nature of unresolved discrepancies at 48 hours post admission, potential for harm averted by clinical pharmacist.	Clinical pharmacists should perform medication reconciliation on admission to the emergency department.	IIIB
115	Pal A, Babbott S, Wilkinson ST. Can the targeted use of a discharge pharmacist significantly decrease 30-day readmissions? Hosp Pharm. 2013;48(5):380-388.	Quasi-experimental	537 patients intervention group, 192 control group.	Discharge review by a pharmacist	No pharmacist review	30-day readmission rate.	The 30-day readmission rate was decreased after the implementation of a pharmacy discharge reconciliation program.	IIB
116	Reis WCT, Scopel CT, Correr CJ, Andrzejevski VMS. Analysis of clinical pharmacist interventions in a tertiary teaching hospital in Brazil. Einstein. 2013;11(2):190-196.	Nonexperimental	6,438 prescriptions	n/a	n/a	Interventions performed by pharmacist to correct prescribing error.	Prescribing errors were caught by the pharmacist prior to the incorrect medication reaching the patient.	IIIB
117	Warden BA, Freels JP, Furuno JP, Mackay J. Pharmacy-managed program for providing education and discharge instructions for patients with heart failure. Am J Health Syst Pharm. 2014;71(2):134-139.	Quasi-experimental	35 patients intervention group, 115 control group.	Pharmacy led patient education	No education	Readmission rates	Readmission rates decreased after pharmacy led medication reconciliation and discharge instructions.	IIB
118	Stasiak P, Afilalo M, Castelino T, et al. Detection and correction of prescription errors by an emergency department pharmacy service. Can J Emerg Med. 2014;16(3):193-206.	Nonexperimental	3,136 prescriptions	n/a	n/a	Medication errors found by pharmacist.	Pharmacists find errors and are able to intervene to correct the error.	IIIA
119	Balling L, Erstad BL, Weibel K. Impact of a transition-of-care pharmacist during hospital discharge. J Am Pharm Assoc. 2015;55(4):443-448.	Nonexperimental	1,011 patients discharged from an academic medical center.	n/a	n/a	Readmission rates and medication interventions made by the pharmacist at discharge.	A pharmacist should assist with educating patients on hospital discharge, intercepting medication errors, and resolving insurance issues.	IIIC

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120	Tripathi S, Crabtree HM, Fryer KR, Graner KK, Arteaga GM. Impact of clinical pharmacist on the pediatric intensive care practice: an 11-year tertiary center experience. J Pediatr Pharmacol Ther. 2015;20(4):290-298.	Nonexperimental	10,963 PICU patients	Pharmacist involvement in care of PICU patients.	No pharmacy involvement	Number of adverse drug events.	The involvement of a pharmacist decreased medication errors.	IIIB
121	Sebaaly J, Parsons LB, Pilch NAW, Bullington W, Hayes GL, Easterling H. Clinical and financial impact of pharmacist involvement in discharge medication reconciliation at an academic medical center: a prospective pilot study. Hosp Pharm. 2015;50(6):505-513.	Nonexperimental	67 medication discharge medication reviews.	n/a	n/a	Cost savings, potential medication errors and 30-day readmission rate.	Pharmacist involvement resulted in cost savings, reduction in medication errors and reduction in 30-day readmission rate.	IIIB
122	Hamblin S, Rumbaugh K, Miller R. Prevention of adverse drug events and cost savings associated with PharmD interventions in an academic level I trauma center: an evidence-based approach. J Trauma Acute Care Surg. 2012;73(6):1484-1490.	Nonexperimental	2,331 patients admitted to trauma unit.	n/a	n/a	Number of pharmacy interventions.	The use of a pharmacist decreased the number of medication errors reaching the patient and is cost effective.	IIIB
123	Cochran GL, Haynatzki G. Comparison of medication safety effectiveness among nine critical access hospitals. Am J Health Syst Pharm. 2013;70(24):2218-2224.	Nonexperimental	9 critical access hospitals, 350 observations.	n/a	n/a	Medication errors	Critical access hospitals have lower medication error rates when a pharmacist is present at least 40 hours per week.	IIIC
124	McCoy AB, Cox ZL, Neal EB, et al. Real-time pharmacy surveillance and clinical decision support to reduce adverse drug events in acute kidney injury: a randomized, controlled trial. Appl Clin Inform. 2012;3(2):221-238.	RCT	278 patients control group, 262 intervention group	Implementation of pharmacy surveillance	No pharmacy surveillance	Potential errors.	Pharmacy surveillance had no incremental benefit over the existing clinical decision support system.	IA

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125	van den Bemt PMLA, van der Schrieck-de Loos EM, van der Linden C, Theeuwes AMLJ, Pol AG; Dutch CBO WHO High 5s Study Group. Effect of medication reconciliation on unintentional medication discrepancies in acute hospital admissions of elderly adults: a multicenter study. J Am Geriatr Soc. 2013;61(8):1262-1268.	Quasi-experimental	1543 ED hospital admissions	Use of a pharmacist to obtain medication history.	Pharmacist or physician obtained medication history.	Number of medication discrepancies.	A pharmacist lead medication history contains fewer errors than a history obtained by a mixed model (physician or a pharmacist).	IIA
126	Bishop MA, Cohen BA, Billings LK, Thomas EV. Reducing errors through discharge medication reconciliation by pharmacy services. Am J Health Syst Pharm. 2015;72(17 Suppl 2):S120-S126.	Nonexperimental	104 patients	n/a	n/a	Medication discrepancies	A pharmacist should be included in the medication reconciliation process.	IIIB
127	Gardella JE, Cardwell TB, Nnadi M. Improving medication safety with accurate preadmission medication lists and postdischarge education. Jt Comm J Qual Patient Saf. 2012;38(10):452-458.	Organizational Experience	1,251 patients	n/a	n/a	Medication discrepancies and rate of readmissions.	There were a lower number of discrepancies on a admission medication completed by a pharmacist than those completed by an RN. The patients having a post discharge phone call from a pharmacist had lower rate of readmissions.	VA
128	Kramer JS, Stewart MR, Fogg SM, et al. A quantitative evaluation of medication histories and reconciliation by discipline. Hosp Pharm. 2014;49(9):826-838.	Nonexperimental	153 ED patients	n/a	n/a	Number of discrepancies	Pharmacists found the highest number of discrepancies compared to nurses and pharmacy technicians.	IIIB
129	Beckett RD, Crank CW, Wehmeyer A. Effectiveness and feasibility of pharmacist-led admission medication reconciliation for geriatric patients. J Pharm Pract. 2012;25(2):136-141.	RCT	41 pharmacy group, 40 resident /intern group	Pharmacy performed medication reconciliation	Resident or intern performed reconciliation	Medication discrepancies.	During medication reconciliation pharmacists found more discrepancies compared to the discrepancies found by the medical resident or the intern.	IB

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130	Aag T, Garcia BH, Viktil KK. Should nurses or clinical pharmacists perform medication reconciliation? A randomized controlled trial. Eur J Clin Pharmacol. 2014;70(11):1325-1332.	RCT	201 patients	Pharmacist group	Nurse group	Time taken for reconciliation and number of discrepancies.	The pharmacist required less time to complete the reconciliation process than the nurses, but there was not a statistical difference in the number of errors found.	IA
131	Zemaitis CT, Morris G, Cabie M, Abdelghany O, Lee L. Reducing readmission at an academic medical center: results of a pharmacy-facilitated discharge counseling and medication reconciliation program. Hosp Pharm. 2016;51(6):468-473.	Nonexperimental	465 patients in intervention group/ patients admitted one year earlier during same time frame.	Medication reconciliation and patient education at discharge.	No reconciliation or discharge education.	30-day readmission rates.	Medication reconciliation and patient education by a pharmacist decreased 30-day readmission rates.	IIIB
132	Centers for Medicare & Medicaid Services. State Operations Manual Appendix L—Guidance for Surveyors: Ambulatory Surgical Centers. Rev. 137; 2015. https://www.cms.gov/Regulations-and-Guidance/Guidance/Manuals/downloads/som107ap_l_ambulatory.pdf. Accessed July 12, 2017.	Regulatory	n/a	n/a	n/a	n/a	CMS regulations for the ambulatory surgery center.	n/a
133	Cole SL, Grubbs JH, Din C, Nesbitt TS. Rural inpatient telepharmacy consultation demonstration for after-hours medication review. Telemed J E Health. 2012;18(7):530-537.	Quasi-experimental	500 prescriptions pre; 504 prescriptions post.	Use of telepharmacy	Non-tele pharmacist	Medication errors found by pharmacist.	Adverse patient outcomes can be prevented by use of telepharmacy.	IIB
134	The Joint Commission. Preventing infection from the misuse of vials. Sentinel Event Alert. June 16, 2014;52. https://www.jointcommission.org/sea_issue_52/. Accessed July 12, 2017.	Expert Opinion	n/a	n/a	n/a	n/a	Provides recommendations for use of single use vials.	VB
135	Horvath G, MacGregor RL. Is your facility properly managing pharmaceutical waste? OR Nurse. 2013;7(5):8-12.	Expert Opinion	n/a	n/a	n/a	n/a	Educate personnel on proper medication disposal, do not use single dose vials, conduct audits to verify disposal techniques are being adhered to.	VB

REFERENCE #	CITATION	EVIDENCE TYPE	SAMPLE SIZE/ POPULATION	INTERVENTION(S)	CONTROL/ COMPARISON	OUTCOME MEASURE(S)	CONCLUSION(S)	CONSENSUS SCORE
136	Buck D, Subramanyam R, Varughese A. A quality improvement project to reduce the intraoperative use of single-dose fentanyl vials across multiple patients in a pediatric institution. Paediatr Anaesth. 2016;26(1):92-101.	Organizational Experience	All patients admitted to one busy OR.	n/a	n/a	Number of patients who received Fentanyl from single dose vials used on more than one patient.	Wasting of Fentanyl and the number of patients who received Fentanyl from single dose vials used on more than one patient decreased after purchasing smaller volume vials.	VA
137	Yadav G, Gupta SK, Bharti AK, Khuba S, Jain G, Singh DK. Case report: syringe swap and similar looking drug containers: a matter of serious concern. Anaesth Pain Intensive Care. 2013;17(2):205-207.	Case Report	n/a	n/a	n/a	n/a	Look-alike medications should be stored in separate locations, double check medications before administration, medications syringes should be labeled and label should be read carefully.	VC
138	Fry RA, Wilton N, Boyes G. Unusual volatile agent switch: implications for checking unsealed volatile agent containers. Anaesth Intensive Care. 2015;43(3):419-420.	Case Report	n/a	n/a	n/a	n/a	An isoflurane bottle was emptied and the solution replaced with cleaning solution therefore these bottles should be stored in a locked compartment.	VC
139	De Winter S, Vanbrabant P, Vi NTT, et al. Impact of temperature exposure on stability of drugs in a real-world out-of-hospital setting. Ann Emerg Med. 2013;62(4):380-387.	Nonexperimental	Laboratory study, 4 medications	n/a	n/a	Medication deterioration	Temperature sensitive medications deteriorate when stored at temperatures beyond recommended ranges.	IIIB
140	Grissinger M. Ambulatory surgery facilities: a comprehensive review of medication error reports in Pennsylvania. Penn Patient Saf Advis. 2011;8(3):85-93.	Nonexperimental	502 medication error reports	n/a	n/a	Types of medication errors.	Report for the state of Pennsylvania containing medication error statistics from ambulatory surgery centers and recommendations for interventions to take to reduce the number of errors.	IIIB
141	Tobias JD, Yadav G, Gupta SK, Jain G. Medication errors: a matter of serious concern. Anaesth Pain Intensive Care. 2013;17(2):111-114.	Expert Opinion	n/a	n/a	n/a	n/a	Provides recommendations for preventing medication errors.	VB
142	Anto B, Barlow D, Oborne CA, Whittlesea C. Incorrect drug selection at the point of dispensing: a study of potential predisposing factors. Int J Pharm Pract. 2011;19(1):51-60.	Nonexperimental	911 dispensing errors	n/a	n/a	Predisposing factors to medication errors.	Medication selection errors are related to confusion caused by look-alike/sound-alike medications.	IIIB
143	Medication safety. J Pharm Pract Res. 2011;41(2):139-143.	Case Report	n/a	n/a	n/a	n/a	Case report of medication error related to confusion caused by look-alike names.	VC

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144	Medication safety. J Pharm Pract Res. 2011;41(1):52-56.	Case Report	n/a	n/a	n/a	n/a	Case report of medication error related to confusion caused by look-alike labels.	VC
145	Cote V, Prager JD. Iatrogenic phenol injury: a case report and review of medication safety and labeling practices with flexible laryngoscopy. Int J Pediatr Otorhinolaryngol. 2014;78(10):1769-1773.	Case Report	n/a	n/a	n/a	n/a	The wrong medication was selected from the cabinet when the medications were in look-alike containers and had look-alike labels.	VC
146	Cohen MR, Smetzer JL. ISMP medication error report analysis—FDA advise-ERR: FDA approves hydromorphone labeling revisions to reduce medication errors; differentiating penicillin from penicillamine; infusion reconnected to the wrong patient; spell out acetaminophen on. Hosp Pharm. 2012;47(1):10-13.	Case Report	n/a	n/a	n/a	n/a	A patient received the wrong medication because of a look-alike situation. A patient received the wrong IV solution after being connected to the roommates solution.	VC
147	Cohen MR, Smetzer JL. ISMP medication error report analysis—drug stability and compatibility; proper use of single-dose vials; what drugs are present on nursing units?; Arixtra—not a hemostat; Pradaxa-Plavix mix-up. Hosp Pharm. 2012;47(8):578-582.	Case Report	n/a	n/a	n/a	n/a	Medication mix-up occurred because of look-alike names.	VC
148	Butala BP, Shah VR, Bhosale GP, Shah RB. Medication error: subarachnoid injection of tranexamic acid. Indian J Anaesth. 2012;56(2):168-170.	Case Report	n/a	n/a	n/a	n/a	Case report of medication error related to the use of the wrong medication when two medications labels were similar.	VC
149	Koczmara C, Hyland S. Drug name alert: potential for confusion between Pradaxa and Plavix. Dynamics. 2011;22(3):25-26.	Case Report	n/a	n/a	n/a	n/a	Case report describing a case where Pardax was given instead of Plavix therefore separate storage areas are advised.	VB
150	Vazin A, Zamani Z, Hatam N. Frequency of medication errors in an emergency department of a large teaching hospital in southern Iran. Drug Healthc Patient Saf. 2014;6:179-184.	Nonexperimental	202 patients admitted to a Canadian emergency department.	n/a	n/a	Medication errors	Medication errors occurred during the administration, prescription, and transcription, phases.	IIIB

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151	Zeraatchi A, Talebian M, Nejati A, Dashti-Khavidaki S. Frequency and types of the medication errors in an academic emergency department in Iran: the emergent need for clinical pharmacy services in emergency departments. J Res Pharm Pract. 2013;2(3):118-122.	Nonexperimental	500 Iranian ED patients. 1291 medications administered.	n/a	n/a	Frequency of medication errors	Medication error occurred during the prescription, transcription, and administration phases.	IIIB
152	Manias E, Kinney S, Cranswick N, Williams A. Medication errors in hospitalised children. J Paediatr Child Health. 2014;50(1):71-77.	Nonexperimental	274 discharge prescriptions	n/a	n/a	Prescribing and transcribing errors.	Medication errors occur during the prescribing and transcribing phases of the medication use process.	IIIB
153	21 USC 13: Drug Abuse Prevention and Control. Subchapter I: Control and enforcement (sections 801-904). US Government Publishing Office. https://www.gpo.gov/fdsys/granule/USCODE-2011-title21/USCODE-2011-title21-chap13/content-detail.html. Accessed July 12, 2017.	Regulatory	n/a	n/a	n/a	n/a	All medications must be prescribed by a licensed practitioner.	n/a
154	Guideline for patient information management. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2017:591-616.	Guideline	n/a	n/a	n/a	n/a	Recommendations address requirements for perioperative nursing documentation.	IVA
155	Neuss MN, Polovich M, McNiff K, et al. 2013 updated American society of clinical oncology/oncology nursing society chemotherapy administration safety standards including standards for the safe administration and management of oral chemotherapy. J Oncol Pract. 2013;9(2 Suppl):5s-13s.	Guideline	n/a	n/a	n/a	n/a	Guidelines for administration of chemotherapeutic medications.	IVB

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156	Shawahna R, Rahman N, Ahmad M, Debray M, Yliperttula M, Decleves X. Impact of prescriber's handwriting style and nurse's duty duration on the prevalence of transcription errors in public hospitals. J Clin Nurs. 2013;22(3-4):550-558.	Nonexperimental	6,583 inpatient prescriptions, 5,329 outpatient prescriptions.	n/a	n/a	Medication errors	The use of tall man lettering, covered decimal points and not using trailing zeros with decimal units reduced medication errors.	IIIB
157	Cohen MR, Smetzer JL. Dangerous close call with wintergreen oil; are 10 mL syringes needed when giving drugs via venous access devices?; use of "NoAC" abbreviation; unsafe frequency notation; 2014-15 targeted medication safety best practices for hospitals. Hosp Pharm. 2014;49(4):325-328.	Case Report	n/a	n/a	n/a	n/a	Case report of a non-approved abbreviation being used and leading to a medication error.	VC
158	Paul IM, Neville K, Galinkin JL, et al. Metric units and the preferred dosing of orally administered liquid medications. Pediatrics. 2015;135(4):784-787.	Guideline	n/a	n/a	n/a	n/a	Recommendations address the use of metric abbreviations	IVC
159	ISMP guidelines for standard order sets. Institute for Safe Medication Practices. http://www.ismp.org/Tools/guidelines/StandardOrderSets.asp. Accessed July 12, 2017.	Guideline	n/a	n/a	n/a	n/a	Guideline covering standard order sets.	IVC
160	Sakushima K, Umeki R, Endoh A, Ito YM, Nasuhara Y. Time trend of injection drug errors before and after implementation of bar-code verification system. Technol Health Care. 2015;23(3):267-274.	Nonexperimental	2867 medication error reports	n/a	n/a	Number of medication errors before and after instituting a bar-code medication administrations system.	A bar-code medication administration system is an effective method to prevent wrong patient medication errors.	IIIB
161	Al-Shaiji TF. Achieving detumescence of ischemic priapism with intra-cavernosal injection of fentanyl: an unexpected outcome of miscommunication error. Curr Drug Saf. 2011;6(3):194-196.	Case Report	n/a	n/a	n/a	n/a	Case report of a medication error resulting from a misunderstood verbal order.	VC

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162	Recommendations to reduce medication errors associated with verbal medication orders and prescriptions. National Coordinating Council for Medication Error Reporting and Prevention. http://www.nccmerp.org/recommendations-reduce-medication-errors-associated-verbal-medication-orders-and-prescriptions. Adopted February 20, 2001. Revised May 1, 2015. Accessed July 12, 2017.	Guideline	n/a	n/a	n/a	n/a	Guideline covering standard order sets.	IVC
163	Hicks RW, Becker SC, Windle PE, Krenzischek DA. Medication errors in the PACU. J Perianesth Nurs. 2007;22(6):413-419.	Nonexperimental	3,023 medication error reports	n/a	n/a	Frequency of types of medication errors.	Report describing the frequency of various types of medication errors.	IIIC
164	Hicks RW, Becker SC, and Cousins DD. MEDMARX Data Report: A Chartbook of Medication Error Findings from the Perioperative Settings from 1998-2005. Rockville, MD: US Pharmacopeia; 2007.	Nonexperimental	11,239 medication errors	n/a	n/a	Frequency of types of medication errors.	Report describing the frequency of various types of medication errors.	IIIC
165	Pharmaceutical compounding—sterile preparations (797). In: USP Compounding Compendium. Rockville, MD: US Pharmacopeial Convention; 2016:40-85.	Guideline	n/a	n/a	n/a	Clinical practice guidelines for compounding medications including time for disposal	The recommendations address the precautions to be taken when compounding medications	IVB
166	Matousek P, Kominek P, Garcic A. Errors associated with the concentration of epinephrine in endonasal surgery. Eur Arch Otorhinolaryngol. 2011;268(7):1009-1011.	Case Report	n/a	n/a	n/a	n/a	Medication dilutions should be prepared outside the OR. Dilutions of the same medications prepared in the facility should have different colored labels.	VC

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167	Dehmel C, Braune SA, Kreymann G, et al. Do centrally pre-prepared solutions achieve more reliable drug concentrations than solutions prepared on the ward? Intensive Care Med. 2011;37(8):1311-1316.	Nonexperimental	100 admixtures made in pharmacy and 100 admixtures made in nursing unit.	n/a	n/a	Medication concentration	Medication admixtures should be prepared in the pharmacy using mechanical assistance.	IIIB
168	Patel S, Loveridge R. Obstetric neuraxial drug administration errors: a quantitative and qualitative analytical review. Anesth Analg. 2015;121(6):1570-1577.	Systematic Review	n/a	n/a	n/a	Reports of medication errors.	Labels must be carefully read, all syringes must be labeled, labels should be double checked with another individual or a machine and only non-Leur lock connections should be used on spinal-epidural devices.	IIIB
169	Cohen MR, Smetzer JL. ISMP medication error report analysis—important change with heparin labels; Benadryl dispensed instead of vitamins for home parenteral nutrition; potassium and sodium acetate injection mix-ups; don't truncate, stem, or shorten drug names. Hosp Pharm. 2013;48(4):267-269.	Case Report	n/a	n/a	n/a	n/a	Medication names should not be abbreviated, truncated, stemmed or shortened on medication labels.	VC
170	Cohen M, Smetzer J. ISMP medication error report analysis—preventing mix-ups between various formulations of amphotericin B; Arixtra is not a hemostat; measurement mix-up; drug names too close for comfort; new vaccine errors reporting program. Hosp Pharm. 2013;48(2):95-98.	Expert Opinion	n/a	n/a	n/a	n/a	Tallman lettering should be used.	VC
171	Emmerton L, Rizk MFS, Bedford G, Lalor D. Systematic derivation of an Australian standard for tall man lettering to distinguish similar drug names. J Eval Clin Pract. 2015;21(1):85-90.		250 pairs of confusable drug names	Application of Tall Man lettering	No Tall Man	Confusable drug names	Tall Man lettering should be used on labels to identify confusable medications.	IIIB

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172	Darker IT, Gerret D, Filik R, Purdy KJ, Gale AG. The influence of "tall man" lettering on errors of visual perception in the recognition of written drug names. Ergonomics. 2011;54(1):21-33.	Nonexperimental	52 medics, 36 pharmacists, 45 pharmacy technicians from United Kingdom.	Tallman lettering	Lower case lettering	Accuracy of reading names of look-alike medications.	Use of tall man lettering on medication labels increased accuracy in drug name perception.	IIIB
173	DeHenau C, Becker MW, Bello NM, Liu S, Bix L. Tallman lettering as a strategy for differentiation in look-alike, sound-alike drug names: the role of familiarity in differentiating drug doppelgangers. Appl Ergon. 2016;52:77-84.	Nonexperimental	16 nurses, 24 other health care providers, 40 lay people.	Tallman lettering	Lower case lettering	Accuracy of reading names of look-alike medications.	Tallman lettering on medication labels should be used help to reduce medication errors.	IIIB
174	Or CKL, Chan AHS. Effects of text enhancements on the differentiation performance of orthographically similar drug names. Work. 2014;48(4):521-528.	Nonexperimental	60 individuals reviewed 120 pairs of drug names.	Label text enhancements (eg, Tall man lettering).	All labels contain lower case lettering.	Drug name differentiation	Text enhancement (eg, tall man lettering increases name differentiation of look-alike drugs.	IIIB
175	Trudeau M, Green E, Cosby R, et al. Key components of intravenous chemotherapy labeling: a systematic review and practice guideline. J Oncol Pharm Pract. 2011;17(4):409-424.	Guideline	n/a	n/a	n/a	n/a	Evidence based guideline for contents of medication labels.	IVB
176	Harkanen M, Turunen H, Saano S, Vehvilainen-Julkunen K. Detecting medication errors: analysis based on a hospital's incident reports. Int J Nurs Pract. 2015;21(2):141-146.	Nonexperimental	671 medication error reports	n/a	n/a	Medication errors	Medication errors were detected from medication error reports to occur in all phases of the medication process. The researchers recommend that interruptions are decreased during the administration of medications.	IIIB
177	Barak M, Greenberg Z, Danino J. Delayed awakening following inadvertent high-dose remifentanil infusion in a 13 year old patient. J Clin Anesth. 2011;23(4):322-324.	Case Report	n/a	n/a	n/a	n/a	Report of a case where a 13 year old received a dose of remifentanil 10 times greater then recommended. Error was the result of an dosage miscalculation.	VC

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178	Cohen MR, Smetzer JL. ISMP medication error report analysis—tragedy in the postanesthesia care unit; mix-ups between risperidone and ropinirole. Hosp Pharm. 2013;48(7):538-541.	Case Report	n/a	n/a	n/a	n/a	Case report describing a mix-up in names and a case of inadequate monitoring.	VC
179	Medication safety. J Pharm Pract Res. 2014;44(1):38-43.	Case Report	n/a	n/a	n/a	n/a	Case report of medication name mix-ups.	VC
180	Cohen MR, Smetzer JL. ISMP medication error report analysis—leucovorin-levoleucovorin mix-up; two error-reduction principles, one change; syringe pull-back method of verifying IV admixtures is unreliable; fleet enema saline is not just saline; ISMP processes health IT. Hosp Pharm. 2013;48(10):803-806.	Case Report	n/a	n/a	n/a	n/a	Case report of a medication error resulting from look-alike medication labels.	VC
181	Cohen MR, Smetzer JL. U-500 insulin safety concerns mount; improved labeling needed for camphor product; cardizem-cardene mix-up; initiative to eliminate tubing misconnections. Hosp Pharm. 2014;49(2):117-120.	Case Report	n/a	n/a	n/a	n/a	Medication error was related to name mix-ups.	VC
182	Cohen MR, Smetzer JL. ISMP medication error report analysis. Hosp Pharm. 2015;50(5):347-350.	Case Report	n/a	n/a	n/a	n/a	Patients should receive education regarding proper medication administration.	VC
183	Shridhar Iyer U, Fah KK, Chong CK, Macachor J, Chia N. Survey of medication errors among anaesthetists in Singapore. Anaesth Intensive Care. 2011;39(6):1151-1152.	Qualitative	176 anesthesiologists	n/a	n/a	Medication errors.	Medication errors occur in the including swapping of syringes, and accidental injection of an incorrect medication.	IIIC
184	Kanji S, Lam J, Goddard RD, et al. Inappropriate medication administration practices in Canadian adult ICUs: a multicenter, cross-sectional observational study. Ann Pharmacother. 2013;47(5):637-643.	Nonexperimental	434 ICU patients	n/a	n/a	Simultaneous administration of two incompatible medications.	Two incompatible medications were observed to be given via the same IV line.	IIIA

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185	Zhou L, Dhopeshwarkar N, Blumenthal KG, et al. Drug allergies documented in electronic health records of a large healthcare system. Allergy. 2016;71(9):1305-1313.	Nonexperimental	1,766,328 patients	n/a	n/a	Presence of medication allergies	Allergies are present in many patients and there is an increase in allergies to ACE inhibitors.	IIIB
186	Echeta G, Moffett BS, Checchia P, et al. Prescribing errors in adult congenital heart disease patients admitted to a pediatric cardiovascular intensive care unit. Congenit Heart Dis. 2014;9(2):126-130.	Nonexperimental	85 adults, 33 pediatric patients	n/a	n/a	Medication errors	Medication dosage should be calculated based on the weight and not the age of the patient because some people are large pediatric patients or small adult patients.	IIIB
187	Modic MB, Albert NM, Sun Z, et al. Does an insulin double-checking procedure improve patient safety? J Nurs Adm. 2016;46(3):154-160.	RCT	266 patients	Double checking of the insulin	No double checking of the insulin	Medication errors	Double checking of insulin reduced administration errors.	IB
188	Girard NJ. Vial mistakes involving heparin. AORN J. 2011;94(6):644, 554.	Case Report	n/a	n/a	n/a	n/a	Case report describing the results of an incorrect dose of heparin with recommendations to correct situation.	VB
189	Gilbar PJ, Seger AC. Fatalities resulting from accidental intrathecal administration of bortezomib: strategies for prevention. J Clin Oncol. 2012;30(27):3427-3428.	Case Report	n/a	n/a	n/a	n/a	Case report describing three situations in which medications were given by the intrathecal route instead of intravenously as intended.	VC
190	Kellett P, Gottwald M. Double-checking high-risk medications in acute settings: a safer process. Nurs Manag (Harrow). 2015;21(9):16-22.	Literature Review	n/a	n/a	n/a	n/a	High risk medications should be double checked prior to administration.	VC
191	Alsulami Z, Conroy S, Choonara I. Double checking the administration of medicines: what is the evidence? A systematic review. Arch Dis Child. 2012;97(9):833-837.	Systematic Review	16 articles	n/a	n/a	Efficacy of double checking medications.	The current evidence is insufficient to support or refute the practice of double checking medications. The researchers recommend clinical trials be performed.	IIIB
192	Ofosu R, Jarrett P. Reducing nurse medicine administration errors. Nurs Times. 2015;111(20):12-14.	Expert Opinion	n/a	n/a	n/a	n/a	Medication errors occur at many phases during the medication administration process and interruptions should be reduced, nurses should be educated on calculations.	VB

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193	Murphy M, While A. Medication administration practices among children's nurses: a survey. Br J Nurs. 2012;21(15):928-933.	Nonexperimental	59 nurses	n/a	n/a	Medication errors	Results of quality programs should be shared with all people involved. Interruptions should be decreased to decrease medication errors.	IIIB
194	McLeod M, Barber N, Franklin BD. Facilitators and barriers to safe medication administration to hospital inpatients: a mixed methods study of nurses' medication administration processes and systems (the MAPS study). PLoS One. 2015;10(6):e0128958.	Nonexperimental	56 drug rounds	n/a	n/a	Interruptions	Interruptions during medication administration should be limited.	IIIB
195	Raban MZ, Westbrook JI. Are interventions to reduce interruptions and errors during medication administration effective?: a systematic review. BMJ Qual Saf. 2014;23(5):414-421.	Systematic Review	n/a	n/a	n/a	n/a	The evidence supporting medication errors being decreased by decreasing interruptions is weak but it is present and processes to reduce the number of interruptions should be instituted in addition to more research being completed.	IIA
196	Williams T, King MW, Thompson JA, Champagne MT. Implementing evidence-based medication safety interventions on a progressive care unit. Am J Nurs. 2014;114(11):53-62.	Organizational Experience	52 RNs before implementation and 48 RNs after.	Implementation of a package of interventions.	No interventions	Adverse drug events and number of interruptions.	Decreasing the number of interventions decreases the number of medication errors.	VB
197	Choo J, Johnston L, Manias E. Nurses' medication administration practices at two Singaporean acute care hospitals. Nurs Health Sci. 2013;15(1):101-108.	Nonexperimental	170 nurses	n/a	n/a	Medication administration errors.	Distractions and environmental factors can effect safe medication administration.	IIIB
198	Bower R, Jackson C, Manning JC. Interruptions and medication administration in critical care. Nurs Crit Care. 2015;20(4):183-195.	Systematic Review	n/a	n/a	n/a	n/a	Interruptions during administration may lead to medication errors, but there is a lack of empirical studies that demonstrate a connection between minimizing interruptions and a reduction in medication errors.	IIIB

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199	Verweij L, Smeulers M, Maaskant JM, Vermeulen H. Quiet please! Drug round tabards: are they effective and accepted? A mixed method study. J Nurs Scholarsh. 2014;46(5):340-348.	Nonexperimental	105 medication administrations pre intervention, 104 post intervention period 1, 104 post intervention period 2.	Wearing tabards	No tabards	Interruptions and medication errors.	The use of drug round tabards decreased the number of interruptions and simultaneously the number of medication errors.	IIIB
200	Fore AM, Sculli GL, Albee D, Neily J. Improving patient safety using the sterile cockpit principle during medication administration: a collaborative, unit-based project. J Nurs Manag. 2013;21(1):106-111.	Organizational Experience	n/a	The sterile cockpit principle	Survey before and after implementation	Interruptions and medication errors.	The use of a sterile cockpit principle (ie, no-interruption zone, indicator or area for medication administration) has a positive impact on patient safety. The researchers provided examples of how to implement the sterile cockpit principle such as use of vests or "Do Not Disturb" signs.	VB
201	Bravo K, Cochran G, Barrett R. Nursing strategies to increase medication safety in inpatient settings. J Nurs Care Qual. 2016;31(4):335-341.	Nonexperimental	1374 patients	n/a	n/a	Interruptions during medication administration.	Interruptions occur frequently during the process of medication administration.	IIIB
202	Pape TM. The effect of a five-part intervention to decrease omitted medications. Nurs Forum. 2013;48(3):211-222.	Organizational Experience	LPNs and RNs on a single medical-surgical unit. 63 control/57 intervention group.	Implementation of Med Safe Protocol	No protocol	Distractions and interruptions.	A medication safety zone should be established. Nurses in zone should not be interrupted. Nurses should wear visible attire during medication administration. A medication safety checklist should be used. A coined reply for should be created for nurses to use when interrupted. Personnel should be educated regarding actions to take to decrease interruptions.	VB
203	Capasso V, Johnson M. Improving the medicine administration process by reducing interruptions. J Healthc Manag. 2012;57(6):384-390.	Organizational Experience	n/a	n/a	n/a	n/a	Interruption during passing medications decreased with the use of signage indicating medication administration in process.	VC
204	Craig J, Clanton F, Demeter M. Reducing interruptions during medication administration: the white vest study. J Res Nurs. 2014;19(3):248-261.	Quasi-experimental	42 nurses from a variety of nursing units.	Wearing a white vest during medication administration.	No vest	Interruptions	The use of a method to indicate "Do not interrupt: decreases interruptions during medication administration and possibly reduce medication errors.	IIB

REFERENCE #	CITATION	EVIDENCE TYPE	SAMPLE SIZE/ POPULATION	INTERVENTION(S)	CONTROL/ COMPARISON	OUTCOME MEASURE(S)	CONCLUSION(S)	CONSENSUS SCORE
205	Fabbri G, Panico M, Dallolio L, et al. Outbreak of ampicillin/piperacillin-resistant Klebsiella pneumoniae in a neonatal intensive care unit (NICU): investigation and control measures. Int J Environ Res Public Health. 2013;10(3):808-815.	Case Report	n/a	n/a	n/a	n/a	Failure to follow various infection control practices resulted in infections in multiple patients. Practices not followed include single dose medication administered to multiple patients.	VC
206	Branch-Elliman W, Weiss D, Balter S, Bornschlegel K, Phillips M. Hepatitis C transmission due to contamination of multidose medication vials: summary of an outbreak and a call to action. Am J Infect Control. 2013;41(1):92-94.	Case Report	n/a	n/a	n/a	n/a	HCV was spread through re-use of needles and use of a single-patient use vial on multiple patients.	VC
207	De Smet B, Veng C, Kruy L, et al. Outbreak of Burkholderia cepacia bloodstream infections traced to the use of Ringer lactate solution as multiple-dose vial for catheter flushing, Phnom Penh, Cambodia. Clin Microbiol Infect. 2013;19(9):832-837.	Case Report	n/a	n/a	n/a	n/a	The use of multiple dose vials should be avoided.	VC
208	Cohen M, Smetzer J. ISMP medication error report analysis—error prevention strategies for strong iodine solution; do not use an insulin pen for multiple patients. Hosp Pharm. 2012;47(4):260-263.	Expert Opinion	n/a	n/a	n/a	n/a	Single use insulin syringes should not be used on more than one patient.	VC
209	Jog M, Sachidananda R, Saeed K. Risk of contamination of lidocaine hydrochloride and phenylephrine hydrochloride topical solution: in vivo and in vitro analyses. J Laryngol Otol. 2013;127(8):799-801.	Nonexperimental	Laboratory study	n/a	n/a	Presence of contaminates in medication	Single use vials of lidocaine become contaminated after the first use even with the application of a new applicator and should not be used on multiple patients. The contamination occurs because of suck back.	IIIB

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210	Baniasadi S, Dorudinia A, Mobarhan M, Karimi Gamishan M, Fahimi F. Microbial contamination of single- and multiple-dose vials after opening in a pulmonary teaching hospital. Braz J Infect Dis. 2013;17(1):69-73.	Nonexperimental	205 vials	n/a	n/a	Medication contamination	Single and multidose vials that were opened, partially used, and were within the use date were contaminated.	IIIB
211	Moore ZS, Schaefer MK, Hoffmann KK, et al. Transmission of hepatitis C virus during myocardial perfusion imaging in an outpatient clinic. Am J Cardiol. 2011;108(1):126-132.	Case Report	n/a	n/a	n/a	n/a	HCV was transmitted between patients by the use of multidose vials and the use of shared needles between multiple patients.	VA
212	Drezner K, Antwi M, Del Rosso P, Dorsinville M, Kellner P, Ackelsberg J. A cluster of methicillin-susceptible Staphylococcus aureus infections at a rheumatology practice, New York City, 2011. Infect Control Hosp Epidemiol. 2014;35(2):187-189.	Case Report	n/a	n/a	n/a	n/a	A series of infections were related to the contamination of a multidose vial.	VC
213	King CA, Ogg M. Safe injection practices for administration of propofol. AORN J. 2012;95(3):365-372.	Expert Opinion	n/a	n/a	n/a	n/a	Use a clean syringe and needle for every patient.	VB
214	Kundra S, Singh RM, Grewal A, Gupta V, Chaudhary AK. Necrotizing fasciitis after spinal anesthesia. Acta Anaesthesiol Scand. 2013;57(2):257-261.	Case Report	n/a	n/a	n/a	n/a	Report of a case of streptococcal necrotizing fasciitis resulting from a contaminated multidose vial.	VB
215	Ersoz G, Uguz M, Aslan G, Horasan ES, Kaya A. Outbreak of meningitis due to Serratia marcescens after spinal anaesthesia. J Hosp Infect. 2014;87(2):122-125.	Case Report	n/a	n/a	n/a	n/a	Reuse of syringes and needles when withdrawing medications from a multiple-dose vial caused an outbreak of meningitis.	VC

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216	Coyle JR, Goerge E, Kacynski K, et al. Hepatitis C virus infections associated with unsafe injection practices at a pain management clinic, Michigan, 2014-2015. Pain Med. 2017;18(2):322-329.	Case Report	n/a	n/a	n/a	n/a	Medication vials should be entered with a new needle attached to a new syringe each time entered.	VC
217	Rashid M, Karagama YG. Study of microbial spread when using multiple-use nasal anaesthetic spray. Rhinology. 2011;49(3):281-285.	Nonexperimental	Laboratory study	n/a	n/a	Contamination of medication	There is no contamination of the nasal spray solution between simulated patients when the tip was changed.	IIIB
218	Hilliard JG, Cambronne ED, Kirsch JR, Aziz MF. Barrier protection capacity of flip-top pharmaceutical vials. J Clin Anesth. 2013;25(3):177-180.	Nonexperimental	15 vials	n/a	n/a	Vial rubber septum contamination	The rubber septum requires decontamination prior to insertion of needle.	IIIB
219	Laha B, Hazra A. Medication error report: intrathecal administration of labetalol during obstetric anesthesia. Indian J Pharmacol. 2015;47(4):456-458.	Case Report	n/a	n/a	n/a	n/a	Case report of a label not being read closely, keeping multiple injections together.	VC
220	Park JC, Herbert EN. Laser goggles alter the perceived colour of drug labels, increasing the risk for drug errors. Can J Ophthalmol. 2013;48(2):e27-e28.	Expert Opinion	n/a	n/a	n/a	n/a	Laser goggles will distort the color of the labels.	VC
221	Dolan SA, Arias KM, Felizardo G, et al. APIC position paper: safe injection, infusion, and medication vial practices in health care. Am J Infect Control. 2016;44(7):750-757.	Guideline	n/a	n/a	n/a	n/a	Guidelines for safe Injection ,infusion, and medication vial practices in health care.	IVB
222	Haas RE, Beitz E, Reed A, et al. No bacterial growth found in spiked intravenous fluids over an 8-hour period. Am J Infect Control. 2017;45(4):448-450.	Nonexperimental	80 IV bags of LR	n/a	n/a	Presence of bacteria	No bacterial growth was found in the solution 8 hours after spiking.	IIIB
223	Preventing catheter/tubing misconnections: much needed help is on the way! Alta RN. 2011;67(2):24-25.	Case Report	n/a	n/a	n/a	n/a	Report of various types of tubing misconnections.	VC
224	Paparella SF, Wollitz A. Mix-ups and misconnections: avoiding intravenous line errors. J Emerg Nurs. 2014;40(4):382-384.	Expert Opinion	n/a	n/a	n/a	n/a	Medication administration tubing should be managed only by qualified individuals.	VC

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225	Simmons D, Phillips MS, Grissinger M, Becker SC; USP Safe Medication Use Expert Committee. Error-avoidance recommendations for tubing misconnections when using Luer-tip connectors: a statement by the USP safe medication use expert committee. Jt Comm J Qual Patient Saf. 2008;34(5):293-296, 245.	Expert Opinion	n/a	n/a	n/a	n/a	Personnel should be educated about types of tubing, making correct connections. Only syringes intended for IV use should be used for IV injections. Policy and procedures should include the need to trace lines.	VB
226	Döring M, Brenner B, Handgretinger R, Hofbeck M, Kerst G. Inadvertent intravenous administration of maternal breast milk in a six-week-old infant: a case report and review of the literature. BMC Res Notes. 2014;7:17.	Case Report	n/a	n/a	n/a	n/a	Breast milk was given intravenously which could have been prevented if the tubing connections were incompatible.	VC
227	Cohen MR, Smetzer JL. ISMP medication error report analysis. Hosp Pharm. 2011;46(2):82-86.	Case Report	n/a	n/a	n/a	n/a	A case report of a patient receiving a medication IV that was intended to be given as a wound irrigant.	VC
228	Cohen MR, Smetzer JL. ISMP medication error report analysis—avoiding inadvertent intravenous injection of oral liquids; medication within intravenous tubing may be overlooked; searching by drug name gives information on wrong drug. Hosp Pharm. 2012;47(11):825-828.	Case Report	n/a	n/a	n/a	n/a	Case report of a patient receiving an oral medication intravenously related to the use of a parenteral syringe instead of an oral syringe.	VC
229	Shenoi AN, Fortenberry JD, Kamat P. Accidental intra-arterial injection of propofol. Pediatr Emerg Care. 2014;30(2):136.	Case Report	n/a	n/a	n/a	n/a	Propofol was administered into an arterial line instead of an IV line.	VC
230	Ross MJ, Wise A. Accidental epidural administration of Syntocinon. Int J Obstet Anesth. 2012;21(2):203-204.	Case Report	n/a	n/a	n/a	n/a	Case report regarding the giving of IV medication into an epidural catheter.	VC

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231	Kilcup M, Schultz D, Carlson J, Wilson B. Postdischarge pharmacist medication reconciliation: impact on readmission rates and financial savings. J Am Pharm Assoc. 2013;53(1):78-84.	Quasi-experimental	243 patients review group, 251 comparison group.	Pharmacist medication reconciliation.	No pharmacist medication reconciliation.	Readmission rates, medication discrepancies and financial savings.	Medication reconciliation by pharmacists can save money, discover medication discrepancies, and decrease hospital readmissions.	IIB
232	Ghatnekar O, Bondesson A, Persson U, Eriksson T. Health economic evaluation of the Lund Integrated Medicines Management model (LIMM) in elderly patients admitted to hospital. BMJ Open. 2013;3(1).	Systematic Review w/ Meta-Analysis	n/a	Medication reconciliation on admission and discharge	Standard care	Cost savings, readmissions.	Medication reconciliation decreases hospital readmissions and has an associated cost savings.	IIB
233	Feldman LS, Costa LL, Feroli ERJ, et al. Nurse-pharmacist collaboration on medication reconciliation prevents potential harm. J Hosp Med. 2012;7(5):396-401.	Nonexperimental	563 patients	n/a	n/a	Discrepancies between pre-admit and post admit medication orders.	Reconciliation can prevent medication discrepancies and it is cost effective.	IIIB
234	Gimenez Manzorro A, Zoni AC, Rodriguez Rieiro C, et al. Developing a programme for medication reconciliation at the time of admission into hospital. Int J Clin Pharm. 2011;33(4):603-609.	Quasi-experimental	1,823 prescriptions before, 1,958 prescriptions after.	Implementation of an electronic medication reconciliation tool.	No electronic medication reconciliation tools.	Unintended medication discrepancies.	Medication reconciliation decreased the number of unintended medication discrepancies.	IIB
235	Selcuk A, Sancar M, Okuyan B, Demirtunc R, Izzettin FV. The potential role of clinical pharmacists in elderly patients during hospital admission. Pharmazie. 2015;70(8):559-562.	Nonexperimental	133 patients age 65 and older.	n/a	n/a	Potential for drug-drug interactions and medication discrepancies.	Medication related problems and inappropriate medication utilization can be prevented by a pharmacist - driven medication reconciliation and medication review program.	IIIB
236	Dodds LJ. Optimising pharmacy input to medicines reconciliation at admission to hospital: lessons from a collaborative service evaluation of pharmacy-led medicines reconciliation services in 30 acute hospitals in England. Eur J Hosp Pharm Sci Pract. 2014;21(2):95-101.	Nonexperimental	3086 patients admitted to 30 acute care hospitals in England.	n/a	n/a	Discrepancies between medication history and medications ordered at admission.	Medication reconciliation identified medication discrepancies thereby improving medication safety.	IIIA

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237	Lee Y, Kuo L, Chiang Y, et al. Pharmacist-conducted medication reconciliation at hospital admission using information technology in Taiwan. Int J Med Inf. 2013;82(6):522-527.	Nonexperimental	3013 patients	n/a	n/a	Medication discrepancies	The medication reconciliation program conducted by pharmacists was effective at finding medication discrepancies.	IIIA
238	Marotti SB, Kerridge RK, Grimer MD. A randomised controlled trial of pharmacist medication histories and supplementary prescribing on medication errors in postoperative medications. Anaesth Intensive Care. 2011;39(6):1064-1070.	RCT	118 patients to usual care, 119 to medication history taken, 120 to medication history and prescribing by pharmacist	Medication history taken by pharmacist, Medication history and corrective prescribing by pharmacist	No history taken	Number of omitted medications.	Medication reconciliation reduces the number of omitted medications postoperatively.	IB
239	Mekonnen AB, McLachlan AJ, Brien JE. Effectiveness of pharmacist-led medication reconciliation programmes on clinical outcomes at hospital transitions: a systematic review and meta-analysis. BMJ Open. 2016;6(2):e010003.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	Pharmacist medication reconciliation during hospital transitions decreases adverse drug related hospital revisits, all-cause readmissions and ED visits.	IIB
240	Becerra-Camargo J, Martinez-Martinez F, Garcia-Jimenez E. The effect on potential adverse drug events of a pharmacist-acquired medication history in an emergency department: a multicentre, double-blind, randomised, controlled, parallel-group study. BMC Health Serv Res. 2015;15:337.	RCT	117 intervention group, 125 usual care group	Medication history taken by pharmacist,	No pharmacist interview	Potential adverse drug events.	Medication reconciliation by a pharmacist may contribute to reducing the risk of potential adverse drug events.	IB
241	Gattari TB, Krieger LN, Hu HM, Mychaliska KP. Medication discrepancies at pediatric hospital discharge. Hosp Pediatr. 2015;5(8):439-445.	Nonexperimental	69 patient charts	n/a	n/a	Medication discrepancies at time of discharge	Medication discrepancies exist at the time of discharge from an inpatient pediatric unit.	IIIB

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242	Ziaeian B, Araujo KLB, Van Ness PH, Horwitz LI. Medication reconciliation accuracy and patient understanding of intended medication changes on hospital discharge. J Gen Intern Med. 2012;27(11):1513-1520.	Nonexperimental	377 patients	n/a	n/a	Patient understanding of medication changes and accuracy of medication lists.	Patients had very little or no knowledge of medication changes between admission and discharge, and medication reconciliation needs to improve.	IIIB
243	Wolf O, Aberg H, Tornberg U, Jonsson KB. Do orthogeriatric inpatients have a correct medication list? A pharmacist-led assessment of 254 patients in a Swedish university hospital. Geriatr Orthop Surg Rehabil. 2016;7(1):18-22.	Nonexperimental	254 patients	n/a	n/a	Number of medication discrepancies.	There is a high number of discrepancies between the actual medications the patient is taking and the list created upon admission to a hospital. A medication reconciliation process can help to decrease the number of discrepancies.	IIIB
244	Yi SB, Shan JCP, Hong GL. Medication reconciliation service in Tan Tock Seng Hospital. Int J Health Care Qual Assur. 2013;26(1):31-36.	Nonexperimental	Admission to facility averaged 4,700 per monthly during study.	n/a	n/a	Medication errors	The most common errors found during reconciliation included transcription errors and omissions.	IIIC
245	González-García L, Salmerón-García A, García-Lirola M, Moya-Roldán S, Belda-Rustarazo S, Cabeza-Barrera J. Medication reconciliation at admission to surgical departments. J Eval Clin Pract. 2016;22(1):20-25.	Nonexperimental	176 patients	n/a	n/a	Medication discrepancies	Medication reconciliation found several medication discrepancies.	IIIB
246	Hohn N, Langer S, Kalder J, Jacobs MJ, Marx G, Eisert A. Optimizing the pharmacotherapy of vascular surgery patients by medication reconciliation. J Cardiovasc Surg. 2014;55(2 Suppl 1):175-181.	Nonexperimental	105 patients admitted for vascular surgery	n/a	n/a	Medication discrepancies	Medication reconciliation found several medication discrepancies.	IIIB
247	Knez L, Suskovic S, Rezonja R, Laaksonen R, Mrhar A. The need for medication reconciliation: a cross-sectional observational study in adult patients. Respir Med. 2011;105(Suppl 1):S60-S66.	Nonexperimental	101 patients admitted to the hospital	n/a	n/a	Medication discrepancies	Medication reconciliation found several medication discrepancies.	IIIB

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248	Mendes AE, Lombardi NF, Andrzejevski VS, Frandoloso G, Correr CJ, Carvalho M. Medication reconciliation at patient admission: a randomized controlled trial. Pharm Pract. 2016;14(1):656.	RCT	46 control group, 39 intervention group	Medication reconciliation and review	No medication reconciliation and review	Length of hospital stay	Medication reconciliation is a good tool to discover medication discrepancies.	IB
249	Holland DM. Interdisciplinary collaboration in the provision of a pharmacist-led discharge medication reconciliation service at an Irish teaching hospital. Int J Clin Pharm. 2015;37(2):310-319.	Nonexperimental	224 patients	n/a	n/a	Medication discrepancies	Medication discrepancies were discovered during medication reconciliation.	IIIB
250	Belda-Rustarazo S, Cantero-Hinojosa J, Salmeron-Garcia A, Gonzalez-Garcia L, Cabeza-Barrera J, Galvez J. Medication reconciliation at admission and discharge: an analysis of prevalence and associated risk factors. Int J Clin Pract. 2015;69(11):1268-1274.	Nonexperimental	814 patients	n/a	n/a	Medication discrepancies	Medication discrepancies were discovered during medication reconciliation.	IIIB
251	Bemt PMLA, Schrieck-de Loos EM, Linden C, Theeuwes AMLJ, Pol AG. Effect of medication reconciliation on unintentional medication discrepancies in acute hospital admissions of elderly adults: a multicenter study. J Am Geriatr Soc. 2013;61(8):1262-1268.	Quasi-experimental	1543 patients	Pharmacist lead medication reconciliation.	No medication reconciliation	Medication discrepancies	Medication reconciliation discovered several medication discrepancies.	IIA
252	Benson JM, Snow G. Impact of medication reconciliation on medication error rates in community hospital cardiac care units. Hosp Pharm. 2012;47(12):927-932.	Quasi-experimental	1,650 orders pre implementation, 1392 post medications.	Medication reconciliation on admission.	No reconciliation	Medication discrepancies	Medication reconciliation decreased the number of intentional and unintentional discrepancies.	IIA
253	Gao T, Gaunt MJ. Breakdowns in the medication reconciliation process. Penn Patient Saf Advis. 2013;10(4):125-136.	Nonexperimental	501 medication error reports	n/a	n/a	Error reports involving medication reconciliation.	Medication reconciliation process should be standardized. The roles and responsibilities of personnel involved in reconciliation should be clearly defined. A standardized medication reconciliation form with a scripted list of questions or prompts should be used.	IIIA

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254	Rubio CB, Garrido PN, Segura BM, Ferrit MM, Calderón AC, Catalá PRM. Medication reconciliation at admission in old patients. Aten Farm. 2014;16(1):13-22.	Nonexperimental	192 patients	n/a	n/a	Discrepancies between pre-admit and post admit medication orders.	Medication reconciliation should be performed.	IIIB
255	Gaspar Carreño M, Gavião Prado C, Costa Nogueira J, et al. Medication reconciliation on admission. Aten Farm. 2014;16(4):273-281.	Nonexperimental	113 patients	n/a	n/a	Medication discrepancies	Medication discrepancies are discovered during the process of reconciliation.	IIIB
256	Hellstrom LM, Bondesson A, Hoglund P, Eriksson T. Errors in medication history at hospital admission: prevalence and predicting factors. BMC Clin Pharmacol. 2012;12:9.	Nonexperimental	670 patients	n/a	n/a	Medication discrepancies	Discrepancies in the medication history were found during medication reconciliation.	IIIA
257	Young L, Barnason S, Hays K, Do V. Nurse practitioner-led medication reconciliation in critical access hospitals. J Nurse Pract. 2015;11(5):511-518.	Quasi-experimental	100 medical records pre and post intervention.	Nurse practitioner led medication reconciliation using standardized protocol and forms.	Nurse led medication reconciliation without standardized protocol or forms.	Medication discrepancies	Medication discrepancies decreased when medication reconciliation is used.	IIB
258	Bell CM, Brener SS, Gunraj N, et al. Association of ICU or hospital admission with unintentional discontinuation of medications for chronic diseases. JAMA. 2011;306(8):840-847.	Nonexperimental	187,912 admissions, 208,468 control group	n/a	n/a	Long term medications not restarted within 90 days of discharge	Patients admitted to a hospital are at a high risk of having long term medications not continued therefore a process of reconciliation should occur.	IIIB
259	Magalhães GF, Santos GN, Rosa MB, Noblat Lde A. Medication reconciliation in patients hospitalized in a cardiology unit. PLoS One. 2014;9(12):e115491.	Nonexperimental	58 patients	n/a	n/a	Medication discrepancies	Medication discrepancies were detected during medication reconciliation and the pharmacist was able to assist in resolving many of the discrepancies.	IIIB

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260	Hellstrom LM, Hoglund P, Bondesson A, Petersson G, Eriksson T. Clinical implementation of systematic medication reconciliation and review as part of the Lund Integrated Medicines Management model—impact on all-cause emergency department revisits. J Clin Pharm Ther. 2012;37(6):686-692.	Quasi-experimental	1216 patients in admission group, 2758 patients in control group.	Medication reconciliation and review.	No medication reconciliation and review.	Number of ED visits, mortality, or re-hospitalizations.	Performing medication reconciliation and medication review did not decrease the number of ED visits, mortality, or re-hospitalizations.	IIA
261	Lehnbom EC, Stewart MJ, Manias E, Westbrook JI. Impact of medication reconciliation and review on clinical outcomes. Ann Pharmacother. 2014;48(10):1298-1312.	Systematic Review	n/a	n/a	n/a	n/a	Medication reconciliation has not demonstrated significant improvements in patient outcomes.	IIIB
262	Cortelyou-Ward K, Swain A, Yeung T. Mitigating error vulnerability at the transition of care through the use of health IT applications. J Med Syst. 2012;36(6):3825-3831.	Expert Opinion	n/a	n/a	n/a	n/a	IT systems should be used to decrease ADE's and that more research be performed especially on the elderly population.	VB
263	Treiber LA, Jones JH. Medication errors, routines, and differences between perioperative and non-perioperative nurses. AORN J. 2012;96(3):285-294.	Nonexperimental	16 perioperative nurses	n/a	n/a	Medication errors	Medication errors are made in all phases of perioperative care.	IIIB
264	Gallo E, Pugi A, Lucenteforte E, et al. Pharmacovigilance of herb-drug interactions among preoperative patients. Altern Ther Health Med. 2014;20(2):13-17.	Nonexperimental	478 patients	n/a	n/a	Patients taking herbal remedies	49.8% of patients were taking an herbal remedy.	IIIA
265	Lee A, Varma A, Boro M, Korman N. Value of pharmacist medication interviews on optimizing the electronic medication reconciliation process. Hosp Pharm. 2014;49(6):530-538.	Quasi-experimental	513 Medical record only, 986 medical record plus interview.	Medical record review plus patient interview.	No interview	Medication discrepancies	More medication discrepancies were identified when the reconciliation process included a review of the medical record and a patient interview compared to reviewing only the medical record.	IIB

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266	Meyer C, Stern M, Woolley W, Jeanmonod R, Jeanmonod D. How reliable are patient-completed medication reconciliation forms compared with pharmacy lists? Am J Emerg Med. 2012;30(7):1048-1054.	Nonexperimental	315 patients	n/a	n/a	Medication discrepancies	Patients did not supply an accurate medication history.	IIIB
267	Lu Y, Clifford P, Bjorneby A, et al. Quality improvement through implementation of discharge order reconciliation. Am J Health Syst Pharm. 2013;70(9):815-820.	Organizational Experience	1893 patients discharged to nursing home in control group, 87 intervention group.	Medication reconciliation at discharge.	No medication reconciliation	Medication-related readmission.	A medication reconciliation process should occur at discharge.	VB
268	Richards M, Ashiru-Oredope D, Chee N. What errors can be identified by pharmacy-led medicines reconciliation? A prospective study. Acute Med. 2011;10(1):18-21.	Nonexperimental	62 patients taking one or more medications upon admission to a hospital.	n/a	n/a	Medication discrepancies	Medication reconciliation identifies various types of medication errors.	IIIB
269	Karapinar-Carkit F, Borgsteede SD, Zoer J, Egberts TCG, van den Bemt PMLA, van Tulder M. Effect of medication reconciliation on medication costs after hospital discharge in relation to hospital pharmacy labor costs. Ann Pharmacother. 2012;46(3):329-338.	Nonexperimental	262 adult patients	n/a	n/a	Medication costs and labor costs	The process of medication reconciliation saved the facility money.	IIIB
270	Philbrick AM, Harris IM, Schommer JC, Fallert CJ. Medication discrepancies associated with subsequent pharmacist-performed medication reconciliations in an ambulatory clinic. J Am Pharm Assoc. 2015;55(1):77-80.	Nonexperimental	500 patients	n/a	n/a	Discrepancies in medications	Medication reconciliation reveals medication discrepancies in medications taken by the patient and those prescribed or not prescribed.	IIIB
271	Leguelinel-Blache G, Arnaud F, Bouvet S, et al. Impact of admission medication reconciliation performed by clinical pharmacists on medication safety. Eur J Intern Med. 2014;25(9):808-814.	Nonexperimental	394 patients in pre and post implementation groups.	Reconciliation	No reconciliation	Medication discrepancies	Medication reconciliation found several medication discrepancies.	IIIB

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272	Mekonnen AB, McLachlan AJ, Brien JE. Pharmacy-led medication reconciliation programmes at hospital transitions: a systematic review and meta-analysis. J Clin Pharm Ther. 2016;41(2):128-144.	Systematic Review w/ Meta-Analysis	n/a	n/a	n/a	n/a	Medication reconciliation found several medication discrepancies especially at admission and discharge.	IIA
273	Deitelzweig S. Care transitions in anticoagulation management for patients with atrial fibrillation: an emphasis on safety. Ochsner J. 2013;13(3):419-427.	Literature Review	n/a	n/a	n/a	n/a	Medication reconciliation and patient education should occur at transition of care.	VB
274	Zoni AC, Duran Garcia ME, Jimenez Munoz AB, Salomon Perez R, Martin P, Herranz Alonso A. The impact of medication reconciliation program at admission in an internal medicine department. Eur J Intern Med. 2012;23(8):696-700.	Quasi-experimental	80 patients pre-intervention, 82 patients post-intervention.	Admission medication reconciliation	No medication reconciliation	Medication discrepancies	Unintended medication discrepancies were decreased after implementing a medication reconciliation process.	IIC
275	Andreoli L, Alexandra J, Tesmoingt C, et al. Medication reconciliation: a prospective study in an internal medicine unit. Drugs Aging. 2014;31(5):387-393.	Nonexperimental	170 patients, 1,515 medications	Medication reconciliation on admission	No reconciliation	Medication discrepancies	Medication reconciliation decreased the number of intentional and unintentional discrepancies.	IIIB
276	Cornu P, Steurbaut S, Leysen T, et al. Effect of medication reconciliation at hospital admission on medication discrepancies during hospitalization and at discharge for geriatric patients. Ann Pharmacother. 2012;46(4):484-494.	Nonexperimental	681 patients	n/a	n/a	Discrepancies in medication histories on admission and on discharge	Medication reconciliation performed at all transitions of care is an intervention to assist with preventing medication discrepancies.	IIIB
277	Shiu JR, Fradette M, Padwal RS, et al. Medication discrepancies associated with a medication reconciliation program and clinical outcomes after hospital discharge. Pharmacotherapy. 2016;36(4):415-421.	Nonexperimental	433 patients	n/a	n/a	Medication discrepancies	Medication discrepancies continued to occur after medication reconciliation was preformed but all were considered to have no effect on the patient.	IIIB

REFERENCE #	CITATION	EVIDENCE TYPE	SAMPLE SIZE/ POPULATION	INTERVENTION(S)	CONTROL/ COMPARISON	OUTCOME MEASURE(S)	CONCLUSION(S)	CONSENSUS SCORE
278	Lee KP, Hartridge C, Corbett K, Vittinghoff E, Auerbach AD. "Whose job is it, really?" Physicians', nurses', and pharmacists' perspectives on completing inpatient medication reconciliation. J Hosp Med. 2015;10(3):184-186.	Qualitative	7 attending physicians, 14 residents, 35 nurses, 22 pharmacists	n/a	n/a	Defining who is responsible for medication reconciliation.	Who is responsible for medication reconciliation needs to be clearly defined.	IIIB
279	De Winter S, Vanbrabant P, Spriet I, et al. A simple tool to improve medication reconciliation at the emergency department. Eur J Intern Med. 2011;22(4):382-385.	Quasi-experimental	260 patients	Use of standardized tool	Interview only without use of tool	Discrepancies found at reconciliation.	The number of medication discrepancies is reduced when a standardized medication history questionnaire is used	IIA
280	Cullinan S, O'Mahony D, Byrne S. Application of the structured history taking of medication use tool to optimise prescribing for older patients and reduce adverse events. Int J Clin Pharm. 2016;38(2):374-379.	Nonexperimental	123 patients	n/a	n/a	Discrepancies in medication histories taken by usual methods and taken using a structured tool.	Use of a structured history of mediation use tool resulted in increased accuracy when compared to the usual interview process.	IIIB
281	Henneman EA, Tessier EG, Nathanson BH, Plotkin K. An evaluation of a collaborative, safety focused, nurse-pharmacist intervention for improving the accuracy of the medication history. J Patient Saf. 2014;10(2):88-94.	Quasi-experimental	50 patients pre, 50 patients post	Implementation of a structured tool	No structured tool	Medication discrepancies	The accuracy of the medication history improved when a structured tool was used.	IIA
282	Narendra PL, Biradar PA, Rao AN. Vanishing bowl of local anesthetics: a lesson for sterile labeling. Anesth Essays Res. 2014;8(3):407-409.	Case Report	n/a	n/a	n/a	n/a	Syringes and bowls containing medication on the sterile field should be labeled.	VC
283	Medication safety. J Pharm Pract Res. 2015;45(1):86-92.	Case Report	n/a	n/a	n/a	n/a	Medication errors were related to name mix-ups.	VC
284	Guideline for sterile technique. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2017:75-104.	Guideline	n/a	n/a	n/a	n/a	Guideline detailing the principles for aseptic technique in the operating room.	IVA
285	Or CKL, Wang H. A comparison of the effects of different typographical methods on the recognizability of printed drug names. Drug Saf. 2014;37(5):351-359.	Nonexperimental	40 engineering students, 40 pharmacy students	n/a	n/a	Name differentiation accuracy	Tall man lettering significantly improved differentiation accuracy between look-alike medications but other typographic styles also improved differentiation accuracy and should be considered.	IIIB

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286	Sakuma M, Ida H, Nakamura T, et al. Adverse drug events and medication errors in Japanese paediatric inpatients: a retrospective cohort study. BMJ Qual Saf. 2014;23(10):830-837.	Nonexperimental	1189 pediatric patients	n/a	n/a	Adverse drug events	The rate of adverse drug events in Japan was similar to the rate in the western countries and most drug errors occur during ordering and monitoring. Interventions to improve medication safety should focus on these two phases.	IIIA
287	Standards for perioperative nursing. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2015:693-708.	Guideline	n/a	n/a	n/a	n/a	Standards of perioperative practice which provide guidelines for perioperative practice.	IVC
288	Cohen MR, Smetzer JL. ISMP medication error report analysis—fatal patient-controlled anesthesia adverse events; name confusion with new cancer drugs; medication safety officer group to become a part of ISMP. Hosp Pharm. 2013;48(9):715-724.	Case Report	n/a	n/a	n/a	n/a	Patients should be monitored after receiving medications according to healthcare organization policy.	VC
289	Guideline for care of the patient receiving local anesthesia. In: Guidelines for Perioperative Practice. Denver, CO: AORN, Inc; 2017:617-628.	Guideline	n/a	n/a	n/a	n/a	Guideline for perioperative care of the patient receiving local anesthesia.	IVC
290	Pfeifer K, Slawski B, Manley A, Nelson V, Haines M. Improving preoperative medication compliance with standardized instructions. Minerva Anestesiol. 2016;82(1):44-49.	Organizational Experience	461 pre, 147 post phase 1, 143 post phase 2.	n/a	n/a	n/a	Patient compliance is improved with the use of a standardized, electronically produced preoperative medication instruction sheet.	VA
291	Chien HY, Ko JJ, Chen YC, et al. Study of medication waste in Taiwan. J Exp Clin Med. 2013;5(2):69-72.	Nonexperimental	102 people who disposed of medications at a collection site.	n/a	n/a	Reasons for not taking the medication.	People discard their medications because they are not aware of proper storage conditions and how to use their medications.	IIIB
292	Warle-van Herwaarden MF, Kramers C, Sturkenboom MC, van den Bemt PMLA., De Smet PAGM; Dutch HARM-Wrestling Task Force. Targeting outpatient drug safety: recommendations of the Dutch HARM-wrestling task force. Drug Saf. 2012;35(3):245-259.	Guideline	n/a	n/a	n/a	n/a	Medication guidelines of the Dutch HARM-Wrestling Task Force.	IVB

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293	Manworren RCB, Gilson AM. CE: Nurses' role in preventing prescription opioid diversion. Am J Nurs. 2015;115(8):34-40.	Expert Opinion	n/a	n/a	n/a	n/a	Patients should be provided with education on taking medications only as prescribed, medications should be taken only by the person for whom they were prescribed, medication security, and disposal.	VB
294	Strauch KA. Invisible pollution: the impact of pharmaceuticals in the water supply. AAOHN J. 2011;59(12):525-533.	Expert Opinion	n/a	n/a	n/a	n/a	Various medications or their derivatives are present in the environment. Patients should be educated about proper disposal methods of unused medications.	VB
295	Trovato JA, Tuttle LA. Oral chemotherapy handling and storage practices among veterans affairs oncology patients and caregivers. J Oncol Pharm Pract. 2014;20(2):88-92.	Organizational Experience	42 patients receiving oral chemotherapy at a VA facility.	n/a	n/a	Oral chemotherapy medication handling, storage, and disposal practices.	Patients should receive education regarding proper medication administration.	VA
296	Perks S, Robertson S, Haywood A, Glass B. Clozapine repackaged into dose administration aids: a common practice in Australian hospitals. Int J Pharm Pract. 2012;20(1):4-8.	Nonexperimental	Clozapine tablets	Storage in controlled room temperature conditions.	Storage in accelerated conditions.	Physical characteristics and chemical stability of the medication.	Patients should be educated regarding the proper handling/storage conditions of medications.	IIIB
297	Beckett VL, Tyson LD, Carroll D, Gooding NM, Kelsall AW. Accurately administering oral medication to children isn't child's play. Arch Dis Child. 2012;97(9):838-841.	Nonexperimental	277 care givers	n/a	n/a	Accuracy of measurement	Patients should be instructed on the correct use of measuring devices when administering medications.	IIIB
298	Armor BL, Wight AJ, Carter SM. Evaluation of adverse drug events and medication discrepancies in transitions of care between hospital discharge and primary care follow-up. J Pharm Pract. 2016;29(2):132-137.	Nonexperimental	43 patients	n/a	n/a	Medication discrepancies	To facilitate the process of medication reconciliation a list of medications that the patient is to be taking should be provided to the patient at discharge.	IIIB

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299	Sarangarm P, London MS, Snowden SS, et al. Impact of pharmacist discharge medication therapy counseling and disease state education: pharmacist assisting at routine medical discharge (project PhARMD). Am J Med Qual. 2013;28(4):292-300.	Quasi-experimental	139 control, 140 intervention.	Pharmacist education at discharge.	No education	Hospital readmission, patient satisfaction and medication adherence.	Pharmacist patient discharge education improved medication adherence and patient satisfaction.	IIB
300	Valente S, Murray LP. Creative strategies to improve patient safety: allergies and adverse drug reactions. J Nurses Staff Dev. 2011;27(1):E1-E5.	Organizational Experience	340 patients and 278 new nurses	n/a	n/a	n/a	The accuracy of patient reported allergies on their medical records increased after receiving an educational flyer on the significance of accurate reporting and nurses reported more adverse drug events or reactions after education on the significance of reporting of these events.	VB
301	Borgsteede SD, Karapinar-Carkit F, Hoffmann E, Zoer J, van den Bemt PMLA. Information needs about medication according to patients discharged from a general hospital. Patient Educ Couns. 2011;83(1):22-28.	Qualitative	21 usual care, 10 intervention group	Consultation regarding medications	No Consultation	Amount of information desired.	Medication counselling should combine verbal and written instructions, and be tailored to the patient's needs.	IIIB
302	Bouraoui S, Brahem A, Tabka F, Mrizek N, Saad A, Elghezal H. Assessment of chromosomal aberrations, micronuclei and proliferation rate index in peripheral lymphocytes from Tunisian nurses handling cytotoxic drugs. Environ Toxicol Pharmacol. 2011;31(1):250-257.	Nonexperimental	20 nurses in both control and experimental groups	n/a	n/a	Cellular DNA damage	The group that handled chemotherapeutic agents had more cellular DNA damage than the control group.	IIIB
303	Connor TH, Lawson CC, Polovich M, McDiarmid MA. Reproductive health risks associated with occupational exposures to antineoplastic drugs in health care settings: a review of the evidence. J Occup Environ Med. 2014;56(9):901-910.	Systematic Review	n/a	n/a	n/a	n/a	Health care workers who are exposed to chemotherapeutic agents seems to raise the risk of congenital malformations, miscarriage and subfertility. Precautions should be taken.	IIIB

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304	El-Ebiary AA, Abuelfadl AA, Sarhan NI. Evaluation of genotoxicity induced by exposure to antineoplastic drugs in lymphocytes of oncology nurses and pharmacists. J Appl Toxicol. 2013;33(3):196-201.	Nonexperimental	20 nurses, 18 pharmacists	n/a	n/a	Genome damage	Genome damage is found in nurses and pharmacists who handle chemotherapy medications therefore precautions need to be taken including regular biomonitoring.	IIIB
305	Gomez-Olivan LM, Miranda-Mendoza GD, Cabrera-Galeana PA, et al. Oxidative stress induced in nurses by exposure to preparation and handling of antineoplastic drugs in Mexican hospitals: a multicentric study. Oxid Med Cell Longev. 2014;2014:858604.	Nonexperimental	30 nurses in both control and experimental group.	n/a	n/a	Oxidative stress biomarkers	The levels of oxidative stress biomarkers were elevated in nurses who handle chemotherapeutic medications.	IIIB
306	Hon C, Abusitta D. Causes of health care workers' exposure to antineoplastic drugs: an exploratory study. Can J Hosp Pharm. 2016;69(3):216-223.	Qualitative	18 health care workers who were exposed to antineoplastic medications	n/a	n/a	Reasons for exposure to antineoplastic medication.	Many exposures to antineoplastic medications are preventable if proper precautions are followed.	IIIB
307	Musak L, Smerhovsky Z, Halasova E, et al. Chromosomal damage among medical staff occupationally exposed to volatile anesthetics, antineoplastic drugs, and formaldehyde. Scand J Work Environ Health. 2013;39(6):618-630.	Nonexperimental	249 nurses exposed to antineoplastic medications, 250 nonexposed individuals.	n/a	n/a	Presence of structural chromosomal aberrations.	The nurses exposed to antineoplastic medications had more chromosomal aberrations than the nonexposed individuals.	IIIB
308	Hon C, Teschke K, Shen H, Demers PA, Venners S. Antineoplastic drug contamination in the urine of Canadian healthcare workers. Int Arch Occup Environ Health. 2015;88(7):933-941.	Nonexperimental	201 health care workers	n/a	n/a	Level of cyclophosphamide	The levels of a chemotherapeutic medication was higher in those who did not receive education on safe handling compared to those who received the education.	IIIB

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309	Controlling occupational exposure to hazardous drugs. Occupational Safety and Health Administration. https://www.osha.gov/SLTC/hazardousdrugs/controlling_occex_hazardousdrugs.html. Accessed July 13, 2017.	Regulatory	n/a	n/a	n/a	n/a	OSHA regulations covering the handling of hazardous medications.	n/a
310	Gulten T, Evke E, Ercan I, Evrensel T, Kurt E, Manavoglu O. Lack of genotoxicity in medical oncology nurses handling antineoplastic drugs: effect of work environment and protective equipment. Work. 2011;39(4):485-489.	Nonexperimental	9 nurses who administer antineoplastic medications using proper precautions, 9 nurses from same unit who do not administer antineoplastic medications, 10 nurses from other units.	n/a	n/a	Amount of genotoxicity	Nurses exposed to antineoplastic medications lack evidence of genotoxicity if PPE is worn and recommended technical equipment is used.	IIIB
311	Occupational Safety and Health Administration. 29 CFR §1910.1200. Hazard communication. US Government Publishing Office. http://www.ecfr.gov/cgi-bin/text-idx?SID=3a88b79bbd5ccb9689a55025239c3ff8&mc=true&node=se29.6.1910_11200&rgn=div8. Accessed July 13, 2017.	Regulatory	n/a	n/a	n/a	n/a	OSHA regulations covering hazardous medications.	n/a
312	Easty AC, Coakley N, Cheng R, et al. Safe handling of cytotoxics: guideline recommendations. Curr Oncol. 2015;22(1):e27-e37.	Guideline	n/a	n/a	n/a	n/a	Canadian guidelines for administration of chemotherapeutic medications.	IVB
313	Hazardous drugs—handling in healthcare settings (800). In: USP Compounding Compendium. Rockville, MD: US Pharmacopeial Convention; 2016:86-103.	Guideline	n/a	n/a	n/a	Expert opinion and research based guideline for handling hazardous medications.	The recommendations address the precautions to be taken when handling hazardous medications.	IVC

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314	Bussieres J, Tanguay C, Touzin K, Langlois E, Lefebvre M. Environmental contamination with hazardous drugs in Quebec hospitals. Can J Hosp Pharm. 2012;65(6):428-435.	Nonexperimental	12 measurement sites within each of 25 hospitals	n/a	n/a	Environmental contamination with cyclophosphamide, ifosfamide, and methotrexate.	Periodic surface contamination should be performed when using cyclophosphamide, ifosfamide, and methotrexate to measure the effectiveness of current practices.	IIIA
315	Ensuring healthcare worker safety when handling hazardous drugs. Oncol Nurs Forum. 2015;42(3):217-218.	Position Statement	n/a	n/a	n/a	n/a	Recommendations for health care organizations to institute when hazardous drugs are present.	IVB
316	Boiano JM, Steege AL, Sweeney MH. Adherence to precautionary guidelines for compounding antineoplastic drugs: a survey of nurses and pharmacy practitioners. J Occup Environ Hyg. 2015;12(9):588-602.	Qualitative	241 nurses, 183 pharmacy practitioners	n/a	n/a	Knowledge of standards on handling antineoplastic medications.	Nurses and pharmacists do not have adequate education on handling antineoplastic medications.	IIIB
317	Lawson CC, Rocheleau CM, Whelan EA, et al. Occupational exposures among nurses and risk of spontaneous abortion. Am J Obstet Gynecol. 2012;206(4):327.e1-327.e8.	Nonexperimental	7,482 female nurses	n/a	n/a	Spontaneous abortion after being exposed to chemotherapeutic medication.	There is an increased risk of spontaneous abortion when exposed to antineoplastic medications.	IIIA
318	Leduc-Souville B, Bertrand E, Schlatter J. Risk management of excreta in a cancer unit. Clin J Oncol Nurs. 2013;17(3):248-252.	Nonexperimental	568 hazardous situation	n/a	n/a	Hazardous situations based on exposure to excreta from patients receiving hazardous medications.	Personnel need education on the proper handling of excreta from patients who are receiving hazardous medications. Policies and procedures on handling of hazardous drugs should be adopted. Personnel should take precautions including wearing of PPE when handling hazardous drugs.	IIIB
319	Meade E. Avoiding accidental exposure to intravenous cytotoxic drugs. Br J Nurs. 2014;23(16):S34.	Literature Review	n/a	n/a	n/a	n/a	Summation review of guidelines for handling of hazardous medications.	VA
320	Vyas N, Yiannakis D, Turner A, Sewell GJ. Occupational exposure to anti-cancer drugs: a review of effects of new technology. J Oncol Pharm Pract. 2014;20(4):278-287.	Expert Opinion	n/a	n/a	n/a	n/a	Evidence based report of precautions to take when handling chemotherapeutic medications.	VB

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321	Villarini M, Dominici L, Piccinini R, et al. Assessment of primary, oxidative and excision repaired DNA damage in hospital personnel handling antineoplastic drugs. Mutagenesis. 2011;26(3):359-369.	Nonexperimental	52 health care workers involved in preparation, transportation, administration and disposal of anticancer agents.	n/a	n/a	Presence of primary, oxidative and excision repaired DNA damage.	There is less primary DNA damage when personal protective equipment is used.	IIIB
322	Menonna-Quinn D. Safe handling of chemotherapeutic agents in the treatment of nonmalignant diseases. J Infus Nurs. 2013;36(3):198-204.	Expert Opinion	n/a	n/a	n/a	n/a	Evidence based guidance for handling chemotherapeutic medications.	VB
323	PB70: Liquid Barrier Performance and Classification of Protective Apparel and Drapes Intended for use in Health Care Facilities. Arlington, VA: Association for the Advancement of Medical Instrumentation; 2012.	Guideline	n/a	n/a	n/a	n/a	Guideline describing the levels of barrier protection for gowns.	IVC
324	Occupational Safety and Health Administration. 29 CFR §1910.134. Respiratory protection. https://www.osha.gov/pls/oshaweb/owadisp.show_document?p_table=standards&p_id=12716. Accessed July 13, 2017.	Regulatory	n/a	n/a	n/a	n/a	OSHA requirements for respiratory protection.	n/a
325	Hon C, Teschke K, Chua P, Venners S, Nakashima L. Occupational exposure to antineoplastic drugs: identification of job categories potentially exposed throughout the hospital medication system. Saf Health Work. 2011;2(3):273-281.	Nonexperimental	275 surface samples taken at drug delivery, drug preparation, transport and drug administration states of the hospital medication system.	n/a	n/a	Contamination of surface	Surfaces were found to be contaminated by chemotherapeutic medications from the time of delivery until waste disposal.	IIIB

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326	Hon C, Teschke K, Chu W, Demers P, Venners S. Antineoplastic drug contamination of surfaces throughout the hospital medication system in Canadian hospitals. J Occup Environ Hyg. 2013;10(7):374-383.	Nonexperimental	229 surfaces	n/a	n/a	Contamination of surface	Surfaces were found to be contaminated by chemotherapeutic medications from the time of delivery until waste disposal.	IIIB
327	Queruau Lamerie T, Nussbaumer S, Decaudin B, et al. Evaluation of decontamination efficacy of cleaning solutions on stainless steel and glass surfaces contaminated by 10 antineoplastic agents. Ann Occup Hyg. 2013;57(4):456-469.	Nonexperimental	Laboratory study	n/a	n/a	Effectiveness of cleaning agent	Various cleaning agents were more effective than others but effectiveness of each agent varied with the contaminate.	IIIB
328	Walton AML, Mason S, Busshart M, et al. Safe handling: implementing hazardous drug precautions. Clin J Oncol Nurs. 2012;16(3):251-254.	Organizational Experience	n/a	n/a	n/a	n/a	Quality project which reviewed the literature regarding precautions to take when working with chemotherapeutic medications.	VB
329	Bohlandt A, Groeneveld S, Fischer E, Schierl R. Cleaning efficiencies of three cleaning agents on four different surfaces after contamination by gemcitabine and 5-fluorouracile. J Occup Environ Hyg. 2015;12(6):384-392.	Nonexperimental	Four cleaning agents used on wood laminate, glass, stainless steel, polyvinylchloride intentionally contaminated with 5-flourouracile and gemcitabine.	n/a	n/a	Presence of antineoplastic medications on surfaces after cleaning.	Cleaning procedures should be adapted to the medication and to the surface type.	IIIB
330	Schierl R, Novotna J, Piso P, Bohlandt A, Nowak D. Low surface contamination by cis/oxaliplatin during hyperthermic intraperitoneal chemotherapy (HIPEC). Eur J Surg Oncol. 2012;38(1):88-94.	Nonexperimental	151 wipe samples during 19 procedures.	n/a	n/a	Presence of platinum.	If careful precautions are followed the levels of platinum are small and safe.	IIIB

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331	Couch J, Burr G, Niemeier MT. Evaluation of exposures to healthcare personnel from cisplatin during a mock interperitoneal operation for cancer treatment. J Assoc Occup Health Prof Healthc. 2011;31(2):17-19.	Expert Opinion	n/a	n/a	n/a	n/a	Report of a simulated surgical procedure involving the use of cicplatin and lists precautions to take.	VA
332	Solid Waste Disposal Act [as amended through Pub L No 107-377, December 31, 2002].	Regulatory	n/a	n/a	n/a	n/a	Lists actions to be taken by generators of hazardous waste.	n/a
333	Souza Oliveira AD, CÃ¢mara Alves AE, Silva JA, Silva Oliveira LF, Medeiros SM. Occupational risks of the nursing team's exposure to chemotherapeutic agents: integrative literature review. Rev Enferm UFPE. 2013;7(3):794-802.	Systematic Review	n/a	n/a	n/a	n/a	Nurses need education on the hazards of handling hazardous medications.	IIIB
334	Hennessy KA, Dynan J. Improving compliance with personal protective equipment use through the model for improvement and staff champions. Clin J Oncol Nurs. 2014;18(5):497-500.	Organizational Experience	n/a	n/a	n/a	n/a	Educational material delivered in various ways increased compliance with wearing of PPE during chemotherapy administration.	VB
335	Boiano JM, Steege AL, Sweeney MH. Adherence to safe handling guidelines by health care workers who administer antineoplastic drugs. J Occup Environ Hyg. 2014;11(11):728-740.	Nonexperimental	2069 health care professionals administered antineoplastic medications.	n/a	n/a	Compliance with safety practices while handling chemotherapeutic agents.	Education on the risks of handling antineoplastic medications is needed because of a low rate of adherence to safety practices.	IIIB
336	Jeong KW, Lee B, Kwon MS, Jang J. Safety management status among nurses handling anticancer drugs: nurse awareness and performance following safety regulations. Asian Pac J Cancer Prev. 2015;16(8):3203-3211.	Nonexperimental	236 nurses	n/a	n/a	Compliance with safety practices while handling chemotherapeutic agents	Nurses should receive education regarding handling anti cancer medications.	IIIB

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337	Polovich M, Gieseker KE. Occupational hazardous drug exposure among non-oncology nurses. Medsurg Nurs. 2011;20(2):79-85.	Expert Opinion	n/a	n/a	n/a	n/a	Personnel working in non-oncology units such as surgery need education on the safe handling of hazardous medications, patient's bodily wastes and clean-up.	VA
338	Hon C, Teschke K, Demers PA, Venners S. Antineoplastic drug contamination on the hands of employees working throughout the hospital medication system. Ann Occup Hyg. 2014;58(6):761-770.	Nonexperimental	225 employees	n/a	n/a	Presence of antineoplastic medications on the hands	The hands of many health care workers who had no direct contact with antineoplastic medications were found to have the medication on their hands therefore all employees should be included in the medical surveillance program.	IIIB
339	Hon C, Teschke K, Shen H. Health care workers' knowledge, perceptions, and behaviors regarding antineoplastic drugs: survey from British Columbia, Canada. J Occup Environ Hyg. 2015;12(10):669-677.	Nonexperimental	120 employees	n/a	n/a	Knowledge of standards on handling antineoplastic medications	Education on the risks associated with antineoplastic medications is needed by all disciplines working in the facility.	IIIA
340	Ladeira C, Viegas S, Padua M, et al. Assessment of genotoxic effects in nurses handling cytostatic drugs. J Toxicol Environ Health A. 2014;77(14-16):879-887.	Nonexperimental	27 nurses with exposure to chemotherapeutic medication, 111 unexposed individuals	n/a	n/a	Presence of micronuclei in the participants blood.	The frequency of micronuclei was greater in the samples of those who were exposed to chemotherapeutic agents and the levels were greater in those who were older.	IIIB
341	Santovito A, Cervella P, Delpero M. Chromosomal damage in peripheral blood lymphocytes from nurses occupationally exposed to chemicals. Hum Exp Toxicol. 2014;33(9):897-903.	Nonexperimental	20 nurses who handle antineoplastic medications, 20 people not exposed to antineoplastic medications.	n/a	n/a	Presence of chromosomal aberrations.	The nurses exposed to antineoplastic medications had more chromosomal aberrations than the nonexposed individuals therefore medical surveillance should be performed.	IIIB
342	Drug Enforcement Administration (DEA), Department of Justice. Disposal of controlled substances. Final rule. Fed Regist. 2014;79(174):53519-53570.	Regulatory	n/a	n/a	n/a	n/a	Regulatory requirements for disposing controlled medications.	n/a

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343	Unused Pharmaceuticals in the Health Care Industry: Interim Report. Washington, DC: Environmental Protection Agency; 2008. https://nepis.epa.gov/Exe/ZyPDF.cgi/P100165B.PDF?Dockey=P100165B.PDF. Accessed July 13, 2017.	Expert Opinion	n/a	n/a	n/a	n/a	Statement from the EPA describing methods and regulations that cover the disposal of medications.	VB
344	Federal Water Pollution Control Act [as amended through Pub L No 107-303, November 27, 2002].	Regulatory	n/a	n/a	n/a	n/a	Controls what types of waste may be placed into waterways	n/a
345	Chiarello M, Minetto L, Giustina SVD, Beal LL, Moura S. Popular pharmaceutical residues in hospital wastewater: quantification and qualification of degradation products by mass spectroscopy after treatment with membrane bioreactor. Environ Sci Pollut Res Int. 2016;23(16):16079-16089.	Nonexperimental	100 Liters of hospital waste water.	n/a	n/a	Presence of medication or medication byproducts.	Medication or medication byproducts were found in hospital wastewater.	IIIB
346	Frédéric O, Yves P. Pharmaceuticals in hospital wastewater: their ecotoxicity and contribution to the environmental hazard of the effluent. Chemosphere. 2014;115(1):31-39.	Nonexperimental	Samples of wastewater from a previous study.	n/a	n/a	Presence of medications in wastewater.	Pharmaceuticals are found in various amounts in hospital wastewater.	IIIC
347	Nguyen H, Pham H, Vo D, et al. The effect of a clinical pharmacist-led training programme on intravenous medication errors: a controlled before and after study. BMJ Qual Saf. 2014;23(4):319-324.	Quasi-experimental	516 IV medication doses pre, 688 medication doses post.	Training program	No training provided	Clinically relevant errors.	Clinically relevant errors decreased after the training.	IIB

REFERENCE #	CITATION	EVIDENCE TYPE	SAMPLE SIZE/ POPULATION	INTERVENTION(S)	CONTROL/ COMPARISON	OUTCOME MEASURE(S)	CONCLUSION(S)	CONSENSUS SCORE
348	Laukaityte E, Bruyere M, Bull A, Benhamou D. Accidental injection of patent blue dye during gynaecological surgery: lack of knowledge constitutes a system error. Anaesth Crit Care Pain Med. 2015;34(1):57-60.	Case Report	n/a	n/a	n/a	n/a	Medication errors can be prevented by all participants having adequate education.	VC
349	Westbrook JI, Rob MI, Woods A, Parry D. Errors in the administration of intravenous medications in hospital and the role of correct procedures and nurse experience. BMJ Qual Saf. 2011;20(12):1027-1034.	Nonexperimental	568 intravenous medication administrations	n/a	n/a	Medication administration errors	Education is needed to help prevent medication errors.	IIIB
350	Karavasiliadou S, Athanasakis E. An inside look into the factors contributing to medication errors in the clinical nursing practice. Health Sci J. 2014;8(1):32-44.	Literature Review	n/a	n/a	n/a	n/a	Nurses should receive education regarding medication error prevention in all related phases of the medication use process.	VB
351	Zyoud AH, Abdullah NAC. The effect of individual factors on the medication error. Glob J Health Sci. 2016;8(12):57756.	Qualitative	255 Jordanian RNs from three public hospitals	n/a	n/a	Impact on individual conditions (eg level of knowledge on calculation) on medication errors.	The researchers recommend Jordanian nurses receive more education on mathematical calculations and medication administration process.	IIIB
352	Thornton P. Medication safety. J Pharm Pract Res. 2015;45(4):450-458.	Case Report	n/a	n/a	n/a	n/a	Education is needed to help prevent medication errors.	VC
353	Niemann D, Bertsche A, Meyrath D, et al. A prospective three-step intervention study to prevent medication errors in drug handling in paediatric care. J Clin Nurs. 2015;24(1-2):101-114.	Nonexperimental	14 student nurses and 23 licensed nurses working in a pediatric unit in Germany. Medication administrations: Baseline - 581, Intervention 1 - 400 Intervention 2 - 498 Intervention 3 - 441	1. 3 page handout containing information on medication handling; 2. 60 minute training course on medication handling guidelines and background information; 3. 56 page comprehensive reference book.	Number of errors before the instituting the project and after instituting each step.	Medication errors related to handling of medications.	All three on the interventions to decrease medication administration errors described should be implemented.	IIIB

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354	Samaranayake NR, Cheung STD, Chui WCM, Cheung BMY. Technology-related medication errors in a tertiary hospital: a 5-year analysis of reported medication incidents. Int J Med Inform. 2012;81(12):828-833.	Nonexperimental	1538 medication errors reported from Jan. 2006 to December 2010 with 263 being technology-related.	n/a	n/a	Errors related to technology.	The reported technology related medication errors were socio-technical errors or device errors. Socio-technological errors are errors that resulted from human interaction with technology. The researchers recommend that the end users be educated on the use of technology and that the process be continuously monitored.	IIIB
355	Hicks RW, Hernandez J, Wanzer LJ. Perioperative pharmacology: patient-controlled analgesia. AORN J. 2012;95(2):255-262.	Expert Opinion	n/a	n/a	n/a	n/a	Patients and the perioperative team need education on the functionality of PCA pumps.	VB
356	Speroni KG, Fisher J, Dennis M, Daniel M. What causes near-misses and how are they mitigated?. Nursing. 2013;43(4):19-24.	Nonexperimental	123 nurses	n/a	n/a	Near-misses	Education should be provided for nurses regarding techniques to avoid and handle near-misses incidents.	IIIB
357	Abbotoy JL, Sessanna L. Hands-on BCMA education for direct care nurses. Nurs Manage. 2012;43(11):15-18.	Expert Opinion	n/a	n/a	n/a	n/a	Describes an education plan for use of bar-code medication administration.	VC
358	Cleary-Holdforth J, Leufer T. The strategic role of education in the prevention of medication errors in nursing: part 2. Nurse Educ Pract. 2013;13(3):217-220.	Expert Opinion	n/a	n/a	n/a	n/a	Education of nurses has a significant role in decreasing medication errors.	VB
359	Leufer T, Cleary-Holdforth J. Let's do no harm: medication errors in nursing: part 1. Nurse Educ Pract. 2013;13(3):213-216.	Expert Opinion	n/a	n/a	n/a	n/a	Nurses must be educated to reduce medication errors.	VB
360	Lu M, Yu S, Chen I, Wang KK, Wu H, Tang F. Nurses' knowledge of high-alert medications: a randomized controlled trial. Nurse Educ Today. 2013;33(1):24-30.	RCT	112 nurses intervention group, 113 nurses control group	PowerPoint presentation on high-alert medications	No presentations	Number of correct answers regarding high-alert medication exam.	Pharmacology education strengthens nurses knowledge on high-alert medications which may reduce medication errors.	IB
361	Gokhman R, Seybert AL, Phrampus P, Darby J, Kane-Gill SL. Medication errors during medical emergencies in a large, tertiary care, academic medical center. Resuscitation. 2012;83(4):482-487.	Nonexperimental	186 medication administrations	n/a	n/a	Medication errors	There is a need for education to prevent medication errors during emergency situations. Tracking errors during emergency situations should occur.	IIIA

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362	Lap FT, Tak KY, So Yuen AS. How to change nurses' behavior leading to medication administration errors using a survey approach in United Christian Hospital. J Nuse Educ Pract. 2014;4(12):17-26.	Qualitative	269 nurses	n/a	n/a	Nurses behaviors during medication administration.	Nurses should have continuing education on medication administration as a means to decrease medication errors.	IIIB
363	Sears K, Goodman WM. Risk factors for increased severity of paediatric medication administration errors. Healthc Policy. 2012;8(1):e109-e126.	Nonexperimental	372 surveys	n/a	n/a	Self reported medication errors.	Lack of training contribute to both the number of medication errors and the severity of the errors.	IIIB
364	Abbasinazari M, Zareh-Toranposhti S, Hassani A, Sistanizad M, Azizian H, Panahi Y. The effect of information provision on reduction of errors in intravenous drug preparation and administration by nurses in ICU and surgical wards. Acta Med Iran. 2012;50(11):771-777.	Quasi-experimental	200 medication administrations before and 200 after education.	Medication administration education	No education	Intravenous medication preparation and administration errors.	Nurses need education on intravenous medication preparation and administration.	IIB
365	Haw C, Stubbs J, Dickens G. Medicines management: an interview study of nurses at a secure psychiatric hospital. J Adv Nurs. 2015;71(2):281-294.	Qualitative	50 nurses in a psychiatric hospital	n/a	n/a	Correct evaluation and responses to vignettes covering medication administration.	Education on medication processes is needed and can be delivered by the use of vignettes.	IIIB
366	Haseeb A, Winit-Watjana W, Bakhsh AR, et al. Effectiveness of a pharmacist-led educational intervention to reduce the use of high-risk abbreviations in an acute care setting in Saudi Arabia: a quasi-experimental study. BMJ Open. 2016;6(6):e011401.	Quasi-experimental	Pre-intervention: 660 handwritten physician orders, medication administration records, and pharmacy dispensing sheets from 482 patients. Post-intervention: 498 handwritten physician orders, medication administration records, and pharmacy dispensing sheets from 388 patients.	Education of all disciplines involved with medications.	No education	Use of high risk abbreviations.	The use of high risk abbreviations decreased after an educational session by a pharmacist on the appropriate use of abbreviations.	IIB

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367	Chedoe I, Molendijk H, Hospes W, Van den Heuvel ER, Taxis K. The effect of a multifaceted educational intervention on medication preparation and administration errors in neonatal intensive care. Arch Dis Child Fetal Neonatal Ed. 2012;97(6):F449-F455.	Quasi-experimental	20 patients pre, 22 patients post	Medication error prevention education	No education	Number of medication errors.	An education program on frequent medication administration and preparations resulted in fewer medication errors.	IIB
368	Lohmann K, Ferber J, Haefeli MF, et al. Knowledge and training needs of nurses and physicians on unsuitable drugs for patients with dysphagia or feeding tubes. J Clin Nurs. 2015;24(19-20):3016-3019.	Nonexperimental	373 nurses, 75 physicians	n/a	n/a	Perceived uncertainties in medication administration.	Additional education is needed for the nursing staff on unsuitable drugs for patients with dysphagia or feeding tubes.	IIIC
369	Keane K. Reducing medication errors by educating nurses on bar code technology. Medsurg Nurs. 2014;23(5 Suppl 1):10-11.	Expert Opinion	n/a	n/a	n/a	n/a	Nurses must be trained on the use of the technology.	VC
370	Alsulami Z, Choonara I, Conroy S. Nurses' knowledge about the double-checking process for medicines administration. Nurs Child Young People. 2014;26(9):21-26.	Qualitative	48 nurses	n/a	n/a	Adherence to the double checking process.	Education on the double-checking process may increase nurses adherence to the process.	IIIB
371	Dabliz R, Levine S. Medication safety in neonates. Am J Perinatol. 2012;29(1):49-56.	Expert opinion	n/a	n/a	n/a	n/a	Summarizes recommendations for contents of reference materials.	VC
372	Implementing real-time point of care documentation: a QI project to address medication administration errors. Online J Nurs Inform. 2014;18(3):1-1.	Organizational Experience	35 nurses pre, 25 nurses post.	Education on benefits of and the expectations around point of care documentation.	No education	Medication errors	Medication errors were reduced with the use of real time point of care documentation.	VB
373	Bucsi R. Documentation errors related to electronic health records. Insight. 2012;37(3):19.	Case Report	n/a	n/a	n/a	n/a	Medication errors in an office setting were related to incorrect entry of medications into electronic medical record.	VB
374	Order scanning systems (and fax machines) may pull multiple pages through the scanner at the same time, leading to drug omissions. Alta RN. 2011;67(1):24-25.	Case Report	n/a	n/a	n/a	n/a	Case report of orders not being received by pharmacy because of multiple pages being fed through fax machine at one time.	VC

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375	Perez-Garcia MdC, Soria-Aledo V, Collantes F. Implementation and evaluation of the medication management in nursing units of a university hospital by means of a quality improvement cycle. Appl Nurs Res. 2016;29:148-156.	Organizational Experience	20 units in a hospital.	n/a	n/a	n/a	A quality improvement program is useful in detecting safety problems and corrective measures can be instituted without additional cost.	VB
376	Nwasor EO, Sule ST, Mshelia DB. Audit of medication errors by anesthetists in north western Nigeria. Niger J Clin Pract. 2014;17(2):226-231.	Qualitative	43 anesthesia professionals in Nigeria	n/a		Medication errors	Fifty six percent of the respondents admitted to making a medication error at some time during their career. The researchers recommend that a mechanism for reporting should be in place in every facility.	IIIC
377	Burch KJ. Using a trigger tool to assess adverse drug events in a children's rehabilitation hospital. J Pediatr Pharm Ther. 2011;16(3):204-209.	Nonexperimental	60 charts	n/a	n/a	Adverse drug events	Use of a trigger tool discovered adverse drug events that were not reported through a voluntary reporting program.	IIIC
378	Carnevali L, Krug B, Amant F, et al. Performance of the adverse drug event trigger tool and the global trigger tool for identifying adverse drug events: experience in a Belgian hospital. Ann Pharmacother. 2013;47(11):1414-1419.	Nonexperimental	240 admissions	n/a	n/a	Adverse drug events	Use of a trigger tool discovered adverse drug events that were not previously reported.	IIIB
379	Nobre C, McKay C. Surveillance of adverse drug events in a large tertiary-care hospital. Conn Med. 2012;76(2):91-94.	Expert Opinion	n/a	n/a	n/a	n/a	Using a trigger tool is an effective way to identify and quantify potential adverse drug events.	VB
380	Harkanen M, Kervinen M, Ahonen J, Voutilainen A, Turunen H, Vehvilainen-Julkunen K. Patient-specific risk factors of adverse drug events in adult inpatients—evidence detected using the global trigger tool method. J Clin Nurs. 2015;24(3-4):582-591.	Nonexperimental	463 patient records	n/a	n/a	Adverse drug events	Trigger tools are an efficient method for identifying adverse drug events.	IIIC

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381	Kung K, Carrel T, Wittwer B, Engberg S, Zimmermann N, Schwendimann R. Medication errors in a Swiss cardiovascular surgery department: a cross-sectional study based on a novel medication error report method. Nurs Res Pract. 2013;2013:671820.	Nonexperimental	119 nurses	MESRT reporting system	Usual reporting system	Number of reported medication errors	The chosen method of self reporting of medication error reporting was more effective at catching medication errors than the existing medication error report.	IIIB
382	Donaldson N, Aydin C, Fridman M, Foley M. Improving medication administration safety: using naive observation to assess practice and guide improvements in process and outcomes. J Healthc Qual. 2014;36(6):58-68.	Nonexperimental	Medications administered to 8,594 patients.	n/a	n/a	Medication errors	Direct observation is an effective tool to use for determining medication errors.	IIIB
383	Taghon T, Elsey N, Miler V, McClead R, Tobias J. A medication-based trigger tool to identify adverse events in pediatric anesthesiology. Jt Comm J Qual Patient Saf. 2014;40(7):326-334.	Organizational Experience	n/a	n/a	n/a	n/a	A hybrid system of reporting adverse drug events should be implemented.	VB
384	Erstad BL, Patanwala AE, Theodorou AA. Comparison of methods for the detection of medication safety events in the critically ill. Curr Drug Saf. 2012;7(3):238-246.	Systematic Review	n/a	n/a	n/a	n/a	A multimodal approach should be used for identifying medication errors.	IIIB
385	Davies K, Mitchell C, Coombes I. The role of observation and feedback in enhancing performance with medication administration. J Law Med. 2015;23(2):316-321.	Organizational Experience	209 nurses pre and post.	n/a	n/a	Ability to correctly perform steps of medication administration process.	Direct observation with immediate feedback improves performance medication administration tasks.	VB
386	Elliott P, Martin D, Neville D. Electronic clinical safety reporting system: a benefits evaluation. JMIR Med Inform. 2014;2(1):e12.	Quasi-experimental	205 employees	Electronic system	Paper system	Number of error reports.	An increase of medication error reporting occurred after the implementation of an electronic error reporting system.	IIB

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387	Meyer-Massetti C, Cheng CM, Schwappach DLB, et al. Systematic review of medication safety assessment methods. Am J Health Syst Pharm. 2011;68(3):227-240.	Systematic Review	n/a	n/a	n/a	n/a	The four medication safety assessment methodologies (eg, review of incident reports, review of charts, direct observation, trigger tools) all have strengths and weaknesses.	IIIB
388	Cronrath P, Lynch TW, Gilson LJ, et al. PCA oversedation: application of healthcare failure mode effect (HFMEA) analysis. Nurs Econ. 2011;29(2):79-87.	Quasi-experimental	84 failure points	Iniation of healthcare failure mode effect analysis process	No healthcare failure mode effect analysis process	Over sedation	Recommends using a healthcare failure mode effect analysis process to address system improvements and ensure patient safety.	IIB
389	Velez-Diaz-Pallares M, Delgado-Silveira E, Carretero-Accame ME, Bermejo-Vicedo T. Using healthcare failure mode and effect analysis to reduce medication errors in the process of drug prescription, validation and dispensing in hospitalised patients. BMJ Qual Saf. 2013;22(1):42-52.	Quasi-experimental	8703 prescriptions before, 10,248 after implementation	Implementation of a computerized prescriber order entry system.	No computerized prescriber order entry system.	Medication error reports.	The use of healthcare failure mode effect analysis lead to identification of actions aimed at reducing medication errors.	IIB
390	Curatolo N, Gutermann L, Devaquet N, Roy S, Rieutord A. Reducing medication errors at admission: 3 cycles to implement, improve and sustain medication reconciliation. Int J Clin Pharm. 2014;37(1):113-120.	Nonexperimental	91 patients	n/a	n/a	n/a	The use of the Plan, Do, Study, Act cycle was successfully used to implement and maintain a medication reconciliation process.	IIIB
391	Ashley L, Dexter R, Marshall F, McKenzie B, Ryan M, Armitage G. Improving the safety of chemotherapy administration: an oncology nurse-led failure mode and effects analysis. Oncol Nurs Forum. 2011;38(6):E436-E444.	Organizational Experience	8 member chemotherapy team	n/a	n/a	n/a	The use of the Failure Mode, and Effects Analysis assisted in identifying several specific chemotherapy failure modes.	VB
392	Cheng C, Chou C, Wang P, Lin H, Kao C, Su C. Applying HFMEA to prevent chemotherapy errors. J Med Syst. 2012;36(3):1543-1551.	Organizational Experience	8,310 before implementation, 10,162 after.	Implementation of a computerized order entry system.	n/a	n/a	Healthcare failure mode effect analysis is a useful tool for evaluating potential risks for adverse events and computerized prescriber order entry systems may be used to decrease medication errors.	VB

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393	Nguyen C, Cote J, Lebel D, et al. The AMELIE project: Failure mode, effects and criticality analysis: a model to evaluate the nurse medication administration process on the floor. J Eval Clin Pract. 2013;19(1):192-199.	Organizational Experience	2 nursing units with an average daily census of 27.	n/a	n/a	Causes of medication adverse events during drug administration.	A failure mode, effects and criticality analysis process is an effective method to identify and prioritize interventions to be taken to decrease medication errors.	VB
394	Beckett RD, Yazdi M, Hanson LJ, Thompson RW. Improving medication safety through the use of metrics. J Pharm Pract. 2014;27(1):61-64.	Nonexperimental	45 health systems	n/a	n/a	Presence of safety metrics, and the reporting venue.	The researchers recommend the use of quality metrics which apply to each individual facility and that the metrics be clear, transferable into an intervention, and be reported to all venues to which the metric applies.	IIIA
395	de Boer M, Ramrattan MA, Boeker EB, Kuks PFM, Boermeester MA, Lie-A-Huen L. Quality of pharmaceutical care in surgical patients. PLoS One. 2014;9(7):e101573.	Nonexperimental	252 medical records	n/a	n/a	Adverse drug events	Using a set of quality is an effective way to identify and quantify adverse drug events.	IIIB
396	Smeulers M, Verweij L, Maaskant JM, et al. Quality indicators for safe medication preparation and administration: a systematic review. PLoS One. 2015;10(4):e0122695.	Systematic Review	n/a	n/a	n/a	n/a	Quality indicators centered on medication safety need to be individualized to the practice setting.	IIIB
397	Rodriguez-Gonzalez CG, Martin-Barbero ML, Herranz-Alonso A, et al. Use of failure mode, effect and criticality analysis to improve safety in the medication administration process. J Eval Clin Pract. 2015;21(4):549-559.	Expert Opinion	n/a	n/a	n/a	n/a	Recommends a process for quality analysis.	VB
398	Miller DF, Fortier CR, Garrison KL. Bar code medication administration technology: characterization of high-alert medication triggers and clinician workarounds. Ann Pharmacother. 2011;45(2):162-168.	Nonexperimental	548,405 scanned medications	n/a	n/a	Nursing and pharmacy workarounds.	Nursing and pharmacy work arounds are present and may decrease effectiveness of alert system therefore workflows must be continually reviewed.	IIIA

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399	Rack LL, Dudjak LA, Wolf GA. Study of nurse workarounds in a hospital using bar code medication administration system. J Nurs Care Qual. 2012;27(3):232-239.	Qualitative	220 surveys; 6 focus groups consisting of 43 participants.	n/a	n/a	Type of and reasons for technological work-arounds.	When a bar coding system is in place the RN staff administering medications use various workarounds to avoid use of the technology. The workarounds were created because not enough outlets were available to charge the units, lack of education on what to do during emergencies, and alterations in work flow reducing efficiency. The researchers recommend that hospital leaders understand the barriers that lead to workarounds and take steps to prevent them.	IIIB
400	Niazkhani Z, Pirnejad H, van der Sijs H, Aarts J. Evaluating the medication process in the context of CPOE use: the significance of working around the system. Int J Med Inf. 2011;80(7):490-506.	Qualitative	21 clinical end-users of the computerized order entry system	n/a	n/a	List of work-arounds resulting from use of a computerized order entry system.	Work arounds may help maintain a smooth workflow, but others may increase the time taken to administer medications and may endanger patient safety.	IIIB
401	Coleman JJ, Hodson J, Brooks HL, Rosser D. Missed medication doses in hospitalised patients: a descriptive account of quality improvement measures and time series analysis. Int J Qual Health Care. 2013;25(5):564-572.	Organizational Experience	2,121,765 medication doses	n/a	n/a	n/a	Sharing of information from a quality study on a dashboard appeared to help decrease missed medication doses.	VA
402	Munn Z, Scarborough A, Pearce S, et al. The implementation of best practice in medication administration across a health network: a multisite evidence-based audit and feedback project. JBI Database System Rev Implement Rep. 2015;13(8):338-352.	Quasi-experimental	1,500 medication administrations baseline and 827 medication administrations during follow-up.	Audit and feedback process	No feedback process	Compliance with standards for medication administration.	The use of an audit and feedback process improved compliance with best practices in medication administration.	IIB