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| Author /Year/ Title | Purpose/ Design/ Theory | Sample/ Patient Demographics/ Setting | Definitions/ Measures/ Procedure | Prevalence/ Causes/ Consequences/ Other |
| Bagheri-Nesami et al. (2015) | Purpose: Determine frequency of IV administration errors and their causes in cardiac critical care units.  Design: Descriptive  Theory: None | Sample: n= 190 nurses;20,240 doses of IV medication.  Patients:  Percent Male: 63.2% (1606/2542)  Mean Age: 60.87 ± 13.25  Ethnicity: Not Reported  Nurses:  Percent Male: 7.8% (15/190)  Mean Age: 33.96 ± 6.61  Ethnicity: Not Reported  Setting: 12 teaching hospitals, critical care units, Iran; November 2014-January 2015 | Definition: Unclear  Measure: Percentage of all (IV) errors  Procedure: Self-administered questionnaires. | Prevalence: Wrong time errors 3.1% (8/262) of total errors reported.  Cause: Measured but not segregated by type  Consequence: Measured but not segregated by type |
| Barker et al. (2002) | Purpose: Identify prevalence of medication errors  Design: Prospective cohort  Theory: None | Sample: n = 36 institutions; 3216 doses; 1 med pass minimum over 1-4 days (high med-volume units)  Percent Male: Not reported  Mean Age: Not reported  Ethnicity: Not reported  Setting: 36 facilities in Denver-Boulder-Greeley, Colorado, and Atlanta, Georgia metropolitan statistical area; 7-month study period | Definition: >60 minutes before/after scheduled time or 30 minutes before after dosing with meal  Measure: Percentage of administrations.  Procedure: Observation | Prevalence – Wrong time errors 8% (259/3216) overall; 6% (85/1481) in accredited hospitals and 11% (31/284) in non-accredited  Cause: not measures  Consequence: 15% of wrong time errors were judged to have potential clinical significance |
| Berdot et al. (2012) | Purpose: Determine incidence, type, and clinical importance of drug administration errors and identify risk factors  Design: Descriptive/exploratory  Theory: None | Sample: n= 28 nurses, 108 patients, 1501 observed administrations  Patients  Percent Male: not reported  Mean Age: not reported  Ethnicity not reported  Nurses:  Percent Male: 0%  Mean Age: 29 (range 21-50)  Ethnicity: not reported  Setting: 4 wards of an 800-bed teaching hospital; Paris, France | Definition: >60 min before/after schedule  Measure: Percentage of administration errors  Procedure: Observation | Prevalence: wrong time errors: 72.6% of total errors (312/430)  Cause: Measured but not segregated by type of error  Consequences: Measured but not segregated by type of error |
| Bohomol et al. (2009) | Purpose: Investigate incidence, types, causes, and consequences of medication errors.  Design: Exploratory, quantitative  Theory: None | Sample: n=44 adult inpatients, ICU  Percent Male: Not reported  Mean Age: Not reported  Ethnicity: Not reported  Setting: ICU Inpatient, single facility, 30-day period, 2006. | Definition: > 15 minutes after scheduled time for medications scheduled for every 4, 6, 8 or 12 hours, or > 30 minutes for daily doses.  Measures: Percentage of all medication errors.  Procedure: Anonymous self-report, staff screening, review of patient charts. | Prevalence: 35/305 wrong time errors occurred 11.5% (2nd highest frequency of medication error).  Causes: Stated but not segregated to type of error  Consequences: Stated but not segregated to type of error. |
| Calabrese et al. (2001) | Purpose: Measure incidence and specify types of medication administration errors from a list of error-prone medications and to determine if patient harm resulted from these errors.  Design: Descriptive  Theory: None | Sample: n = 5,744 medication administration observations in 851 patients. utilized error prone medications observation and evaluation for harm.  Percent Male: Not reported  Mean Age: Not reported  Ethnicity: Not reported  Setting: 3-month time period, July-October, 1999. Five USA ICU’s. 2 observations per day per patient. | Definition: >60 min before/after schedule  Measure: Percentage of administration errors.  Procedure: Observation of medication administration | Prevalence – 13.9% (26/187) of errors were wrong time errors  Cause: not measured  Consequences – Measured but not segregated by type of error |
| Chua et al. (2009a) | Purpose: determine extent and types of drug administration errors in two pediatric wards and identify measures to reduce such errors  Design: Descriptive  Theory: None | Sample: n= 857 drug administrations  Percent Male: Not reported  Mean Age: Not reported  Ethnicity: Not reported  Setting: Two paediatric wards, teaching hospital, Malaysia | Definition: >60 minutes before/after scheduled dose  Measure: Percentage of administration errors.  Procedure: Observation | Prevalence: wrong-time most common (28.8%)30/104 error  Causes: Stated but not segregated to type  Consequences: not measured |
| Chua et al. (2009b) | Purpose: Determine frequency and types of drug administration errors.  Design: Prospective cohort/ descriptive  Theory: None | Sample: n= 1118 medication administrations/ opportunities  Patients:  Percent Male: Not reported  Mean Age: Not Reported  Ethnicity: Not reported  Setting: 22-bed Haematology ward of teaching hospital in Malaysia. 8 weeks, November 2004- January 2005 with 15 working days (each Wed/Friday excluding one holiday) from 0730-2100 | Definition: >60 minutes before/after scheduled dose.  Measure: Percentage of administration errors.  Procedure: Undisguised observation | Prevalence: 34/127 errors 25.2%  Cause: Not measured  Consequences: Not measured |
| Ernawati et al. (2014) | Purpose: Determine nature and frequency of medication errors during medication delivery processes  Design: Prospective cohort  Theory: None | Sample: n= 92 patients/ 770 drug orders/ 7662 drug dose  Percent Male: 60% (55/92)  Mean Age: 71.4±7.5 years  Ethnicity: Not reported  Setting: 13-bed geriatric ward, public teaching hospital, Bali, Indonesia | Definition: Unclear  Measure: Percentage of administration errors.  Procedure: Observation | Prevalence: 35/927 (3.78%) errors were wrong time  Cause: Measured but not segregated by type of error  Consequences: Measured but not segregated by type of error |
| Feleke et al. (2015) | Purpose: Assess magnitude/associated factors of medication administration errors  Design: Prospective observational, cross-sectional  Theory: None | Sample: n= 360 medication administrations, 82 nurses, and 263 patients.  Patients:  Percent Male: 46.4% (122/263)  Mean Age: Not reported  Ethnicity: Not reported  Nurses:  Percent Male: 15.9% (13/82)  Mean Age: 31 ± 6.4  Ethnicity: Not reported  Setting: Felege Hiwot (Ethiopia), Referral Hospital. Inpatient Department. March 24-April 7, 2014. | Definition: >30 min before/after schedule  Measure: Percentage of medications administered.  Procedures: Observation, survey | Prevalence: Timing errors 193/360 (53.6%)  Cause: Measured, but not segregated by type of error.  Consequences: not measured |
| FitzHenry et al. (2007) | Purpose: Identify errors in CPOE environment.  Design: Descriptive  Theory: None | Sample: n=190 patient charts  Percent Male: Not reported  Mean Age: 64  Ethnicity: Not reported  Setting: Vanderbilt University Hospital, Nashville, TN; adult sub-acute, acute, and CCU; 1999-2003 | Definition: >60 minutes before/after scheduled.  Measures: Percentage of administrations, percentage of orders.  Procedure: Retrospective chart review | Prevalence: 916/5426 (dose) administrations; 16.9% wrong time errors 646/1502 orders; 43% wrong time errors.  Causes: not measured  Consequences: not measured. |
| Hernandez et al. (2015) | Purpose: Assess impact of the implementation of (CPOE) associated with pharmacy checks of medication orders in 3 stages of drug management.  Design: Quasi-experimental  Theory: None | Sample: n=111 pre-implementation patient charts and 86 post-implementation patient charts, 1593 pre-implementation medication orders and 1388 post-implementation medication orders  Percent Male: Pre-implementation 46% (51/111); Post implementation 44.2% (38/86)  Mean Age: Pre-implementation 64 (range 48-81); Post-implementation 61 (range 44-83)  Ethnicity: Not reported  Setting: Paris, France, 66-bed orthopaedic surgery ward, 700-bed teaching hospital. Pre-implementation observation two 24-hour periods (Jan 15–16th 2013 and Feb 28th-Mar 1st 2013), post-implementation observation period (Jun 17–18th 2013 and Jul 3–4th 2013). | Definition: 60 minutes before/after schedule  Measure: Percentage of administrations.  Procedure: Pre/Post observation study utilizing patient charts and medication dispensing | Prevalence: Timing errors pre-implementation 8/1222 (0.7%) post-implementation 28/1413 (2.%)  Causes: Study measured CPOE implementation as a potential cause. Overall CPOE lead to a 17.5% significant decrease in administration errors and a .6% decrease in timing errors.  Consequences: Not measured |
| Hicks et al. (2004) | Purpose: Summarize study records from USP’s MEDMARX database of medication errors for 2002  Design: Summary of data  Theory: None | Sample n= 192,477 medication error records (482 participating facilities)  Percent Male: Not reported  Mean Age: Not reported  Ethnicity: Not reported  Setting: MEDMARX database of medication errors, 2002. | Definition: Not defined – Reported from facilities.  Measure: Percentage of all errors.  Procedure: Review of MEDMARX database | Prevalence: timing errors 6.9% (83,753/192,477) of all reported medication errors  Cause: Measured but not segregated by type of error  Consequence: 1% (121/83,753) of all timing errors caused harm |
| Lisby et al. (2005) | Purpose: To investigate the frequency, type, and consequences of medication errors in more stages of the medication process, including discharge summaries.  Design: Cross-sectional  Theory: None | Sample: n= 64 patients in-hospital; 2467 opportunities for errors  Percent Male: 46.9% (30/64)  Mean Age: Medical ward- 55 (95% CI: 48–62); Surgical ward, 62 (95% CI: 56–68)  Ethnicity: Not reported  Setting: One medical-surgical unit in Denmark; January-April, 2003 | Definition: Unclear – utilized guideline  Measure: Percentage of administration errors.  Procedures: Direct observation, control visits, chart reviews | Prevalence: Wrong time medication errors 10.8% (18/166)  Cause: not measured  Consequences: Measured but not segregated by type of error |
| Morelock & Kirk (2019) | Purpose: identify patterns of medication errors with respect to shifts, day of week, unit involve, severity, medication class and cause of errors and propose possible solutions.  Design: Retrospective exploratory  Theory: None | Sample: n= 605 medication events  Percent Male: Not reported  Mean Age: Not reported  Ethnicity: Not reported  Setting: 2 urban medical centers, North Texas; January 2016-July 2017 | Definition: Unclear  Measure: Percentage of administration errors.  Procedure: Data abstraction from self- reports | Prevalence: Early 106 (17.5%); Late 132 (21.8%) (when combined as wrong-time this most common)  Causes: Stated but not segregated to type of administration error.  Consequences: Stated but not segregated to type of administration error. |
| Noguchi et al. (2016) | Purpose: Clarify epidemiology of medical errors and risk factors for non-intercepted and unidentified medical errors.  Design: Prospective cohort study (Longitudinal)  Theory: None | Sample: n= 3459 patients  Percent Male: 57% (1948/3459)  Mean Age: 62% >65 years (2155/3459)  Ethnicity: Not reported  Setting: Three tertiary teaching hospital; Adult medical and surgical wards, Japan; January-June, 2004 | Definition: Unclear  Measure: Percentage of medication errors.  Procedure: Data abstraction | Prevalence: Wrong time 5 total errors (1.0 %)  Cause: Not measured  Consequences: Not measured |
| Poon et al. (2010) | Purpose: Identify changes in error rates with bar-code implementation  Design: Before/after quasi experimental  Theory: None | Sample: n= 14041 medication administrations, 6723 without bar-code and 7318 with barcode; 3082 order transcriptions  Patients:  Percent Male: Medical unit without bar code 53% (n not reported); with bar code 48% (n not reported); Surgical unit without bar code 54% (n not reported); with barcode 53% (n not reported) Intensive care unit without bar code 53% (n not reported); with barcode 51% (n not reported)  Mean Age: Medical unit without bar code 64.3±17.1; with bar code 64.6±16.5; Surgical unit without barcode 58.5±17.0; with barcode 58.4±17.8; Intensive care unit without barcode 62.4±16.7; with barcode 61.3±15.3  Ethnicity: Not reported  Nurses: Not reported  Percent Male: Not reported  Mean Age: Not reported  Ethnicity Not reported  Setting: One 735 bed tertiary academic facility, 35 adult medical-surgical and intensive care units, 9 months 2005. USA | Definition: >60 minutes before/after scheduled,  Measure: Percentage of errors in administrations.  Procedure: Observation | Prevalence: before barcode 16.7% (1126/6723) without barcode; 12.2% (1126/7318) with 891 barcode (27.3% reduction)  Causes: Not measured – Interventional  Consequences: Not measured - Interventional |
| Ramya & Vineetha (2013) | Purpose: Determine defined medication error, commonly observed types, drugs involved, and causes. Study barriers to reporting medication errors.  Design: descriptive/exploratory survey  Theory: None | Sample: n=50 nurses with minimum one year experience  Percent Male: 14% (7/50)  Mean Age: Not reported  Ethnicity: Not reported  Setting: Indian facility, cardiac wing, tertiary care teaching hospital; January – February 2013 | Definition: >60 min before/after schedule.  Measure: Percentage of administration errors.  Procedure: Exploratory survey | Prevalence: Self-reported wrong-time medication administration observation was 13% of reported errors.  Causes: Stated but not segregated by type of error  Consequences: not measured  Other: Barriers of reporting stated but not segregated by type. |
| Taufiq et al. (2015) | Purpose: Measure of the prevalence and contributing factors of wrong time medication administration errors via electronic medical administration record.  Design: Descriptive  Theory: None | Sample: n= 250,213 observed doses  Percent Male: Not reported  Mean Age: Not reported  Ethnicity: Not reported  Setting: Tertiary care hospital in Pakistan, 5 inpatient areas medical, surgical, coronary care, intensive care, and pediatric units (37% of total inpatient bed); 3-month period Feb 10, 2012-May 9, 2012. | Definition: Unclear  Measure: Percentage of doses  Procedure: Abstraction of data via electronic medication administration record | Prevalence: 39,386 wrong-time administration/ 231,380 administered doses (17%).  Causes: Early administration: Nurse related: no reasons given 30.4% no reason given, 31.8% unclear reasons; Patient related: 5.6% due to patient condition, .8% patient wanted to sleep early; system related: 54.4% pre-meal requirement; 1.9% due to planned procedure; 1.05% per doctor order. Misc. reasons 4.3%  Late medications Pharmacy related: 12.2% med late from pharmacy; nursing related: Nurse busy 11.5%; 6.4% forgot to document; 21.4% no reason; 8.4% on time but updated late; Patient related: sleeping 3.6%, refusal 2.9%, patient gone 2.9%; System related: emergency use of medication and later refurbished from pharmacy 2.3%; Medication administration time dependent of procedure 4.2%, multiple IV medications at same time 3.8%; other and technical 3.7% technical issues, misc. 2.6%  Consequences: not measured. |
| Tissot et al. (1999) | Purpose: Assess  type, frequency, and potential clinical significance of medication-administration errors  Design: Prospective  Theory: None | Sample n= 2009 nursing medication administrations, 26 patients.  Percent Male: Not reported  Mean Age: Not reported  Ethnicity: Not Reported  Setting 3-unit, 15-bed medical ICU, University Hospital, Besancon, France, 30 days during a 2-month period. | Definition: >60 min before/after schedule  Measure: Percentage of administrations.  Procedure: Observation | Prevalence: Wrong time errors 3.7% (9/243) of administrations.  Cause: not measured.  Consequences: These errors were potentially clinically significant (55.5%) |
| Tsegaye et al. (2020) | Purpose: Assess medication  administration errors and associated factors  Design: Cross-sectional  Theory: None | Sample: n= 414 nurses  Percent Male: 45.7% (189/414)  Mean Age: 30 years with interquartile range (IQR)27–33 years.  Ethnicity: Not reported  Setting: Ethiopia, referral hospitals of Amhara regional state. March 1-30, 2019 | Definition: Defined as not administered at scheduled time  Measure: Percentage of nurses reporting a wrong-time medication error as a percentage of overall administrations.  Procedures: Observation/ Self-report | Prevalence: Wrong time 38.6% 62/414  Cause: Measured but not segregated by type of error  Consequences: Not Measured |
| Welton et al. (2018). | Purpose: Test ability to use large data set to extract time-referenced data to identify medication late doses and PRN administration patterns by RN’s in inpatient setting  Design: Retrospective, exploratory  Theory: None | Sample: n=3,043,812 doses, 50,883 patients, 714 nurses  Patients:  Percent Male: 49.3% (25097/50832)  Mean Age: 39 (Range 0-102)  Ethnicity: Hispanic/Latino 42.1% (20999/50832); White 40.6% (20249/50832); African American 14% (6984/50832); Asian 1% (1455/50832); Other or Unknown 1.3% (639/50832); American/Alaskan Native 1.2% (557/50832)  Nurses:  Percent Male: Not reported  Mean Age: Not reported  Ethnicity: Not reported  Setting: Single urban 525-bed hospital; 11 inpatient units; Western state, April1, 2013-March31, 2015 | Definition: 60 minutes before/after schedule  Measure: Percentage of scheduled meds..  Procedure: Data extraction from electronic health record | Prevalence: Average of late medications per shift 12.1%; anti-infective were 11.8-12.9% late (60 min) and 30.1-32.7% late (30 min); insulin and anticoagulant 9.4-11.1% late 60 minutes and 19.2-27.7% (30 min). Total of measured medications given late 70,584 (6.47%) (60 min) and 177,650 (16.28%) (30 min) of a total of 1,204,445 administration opportunities.  Causes: Not measured  Consequences: Not measured |
| Westbrook et al. (2010) | Purpose: Test hypothesis that interruptions during medication administration increase errors.  Design: Descriptive  Theory: None | Sample: n= 98 nurses, 4271 medications, 720 patients  Patients:  Percent Male: Not reported  Mean Age: Hospital A - 72.6 years (95% CI, 71.1-74.0); Hospital B - 67.5 years (95% CI, 65.0- 70.0)  Ethnicity: Not Reported  Nurses:  Percent Male: Not reported  Mean Age: Not reported  Ethnicity: Not Reported  Setting: 6 wards in 2 teaching hospitals; Sydney, Australia; 505 hours from September 2006 through March 2008. | Definition: >60 min before/after schedule, or >30 minutes before/after if scheduled with meal  Measure: Percentage of administrations.  Procedure: Observation | Prevalence: wrong-time errors 16.1% (688/4271)  Cause: not measured  Consequence: major errors (severity) occurred in 4.1% of wrong-time errors |
| Wondmieneh et al. (2020) | Purpose: Assess magnitude and contributing factors of medication administration error among nurses in tertiary care hospitals.  Design: Cross-sectional  Theory: None | Sample: n=298 nurses, 225 medication doses.  Percent Male: 33.6% (100/298)  Mean Age: 27.2 years, SD =5.1  Ethnicity: Not Reported  Setting: Addis Adaba, Ethiopia, February-March, 2018 | Definition: >60 min before/after schedule  Measure: Percentage of errors in administrations.  Procedures: Self-administered questionnaires. Observation | Prevalence: observation 44.7% wrong-time errors. Last 12 months, 57.8% (117/298) nurses reported having at least 1 wrong-time error  Causes: Measured but not segregated by type of error  Consequences: Not measured. |