Smart pumps

Business

Description of studies: Six articles were included for review. These six studies met the inclusion criteria that were mentioned before.

For the summary of articles, see appendix ?. These studies were have held and published in the period 2001 to 2010. All the studies were done in the USA except one (P L Trbovich, 2010) that was done in Toronto, Canada. Two of the six studies were implemented in intensive care units (Jeffrey, 2005; Teryl K., 2007) while the other three were done in the whole hospital. Only one study was done in paediatric ICU.

All of them were done in real patient care setting except one study (P L Trbovich, 2010) which was done in simulated inpatient unites. The design of the studies was variable. Only one study was experimental study (P L Trbovich, 2010) while the rest varied between observational prospective to retrospective studies. Despite this variation, all the studies made a comparison between the period before implementation of the smart pump and the period after that from different angles. Study objectives: These studies assessed the impact of smart pumps technology in one of the following: Medication errors, the incidence and nature (Jeffrey M. 2005) Errors reporting rate (Gitte Y.

2005 ; James A. 2002) Type, frequency and severity of medication errors (Carolyn K. 2005) Matching of preventable IV adverse drug events with safety feature of smart pump (Teryl K. 2007). Cost and time of implementation (James A. 2002; Carolyn K.

2005). Type of errors: Many IV errors were documented in some of these studies. Some of these errors were common among the studies where some

were related to specific study. The most common IV administration error was wrong dosing. The percentage of this error was 32% (Teryl K, 2007); 76% on control period and 95% in intervention period (Jeffrey M, 2003). Also, wrong dosing was seen in P L Trbovich and James A.

studies. The second error in occurrence was overriding error. The percentage was 24% after intervention (Jeffery M, 2003) and 88% (Carolyn K, 2005). Other errors that observed in these studies were: Wrong infusion rate (10 % and 6% before and after intervention, Jeffery, 2003; James A.; 1%, Teryl K, 2007). Wrong concentration (1%, Teryl K; 6% and 3% before and after intervention respectively, Jeffery, 2003).

Wrong patient (P L Trbovich). Failure to monitor and intervene (Teryl K). Secondary infusion error (P L Trbovich). Specific finding: – Gitte Y (2005) study showed 73% reduction in the number of reported errors after implementation of smart pump and the error rate decreased from 3. 1 to 0. 8 per 1000 doses with absolute risk reduction of 2.

3 errors per 1000 doses (p

05). For “ wrong dose hard limit” nurse remedied 79%, 75%, and 38% errors when using barcode pump, smart pump , and traditional pump respectively(p

In addition to that, the low cost when compared to CPOE (computerized prescriber-order-entery) and bar-code systems. Discussion: Smart pump as mentioned before, are designed to significantly reduce medication errors and also provide data to support continuous quality improvement initiatives for increasing patient safety. These pumps contain software programs known as

a dose error reduction system (DERS). Most DERS provide the following primary medication management safety features: Drug library Drug dose limits(soft and/or hard limits) Confirmation screen Alert indicators. These pumps were introduced to the market in order to prevent theIV medication errors that cannot be prevented by standard or traditional pump like wrong dose calculation, wrong concentration, wrong rate and multiple of ten errors.

In this review I looked at some available literature to see the impact of introducing smart pump in IV medication error and patient safety. In one study, the introduction of smart pump decreased the errors reported with continuous medication infusion by 73 %(Gitte Y, 2005). Gitte Y. analysed the data reported in the year before changing to smart pump (2002) compared with the year after (2003) and the result was that the error rate dropped from 3. 1 to 0.

8 per 1000 doses, and the number of 10-fold errors decreased from 0. 41 to 0. 08 per 1000 doses. In this study, the use of smart pump helped in reducing the risk coming0 from calculation errors allowing practitioners to change the dose directly. Also the pump provided practitioners with a complete and accurate account of what is beginning to be delivered to the patient and alert them when dose exceeds the limits.

In this study, there were two other practice change done concurrently with the introduction of smart pump; standard concentration and redesigned labels. Although the outcome was very promising, we cannot find the extent of smart pump effect on medication error rate alone. Other two studies analysed the effect of smart pump by measuring the ADE (adverse drug

event). Jeffrey M (2005) in his study found that smart pump with DS (decision support) intercepted potentially harmful errors but there were many errors that were not detected by the smart pump especially in the administration phase. This is included infuse of the drug in wrong rate different from ordered one (the rate was with smart pump limit), and weight-based dosing (also the result was not outside the alert limit). In addition to all that , the study illustrated that the use of smart pump did not reduce the rate of serious medication errors and the author refer that to two problematic intravenous administration practices that frequently happened during the study: by passing the drug library and overriding the alerts .

The investigators did some correction for both library bypassing and alert overrides, and this result in the decreased rates of preventable ADEs and nonintercepted potential ADEs from 0. 28 to 0. 18 (p = 0. 27) and from 2. 12 to 0. 36 (p <.>

0001) per 100 patient-pump days, respectively. The second study that examined the effect of smart pump in preventable iv-ADEs was done by Teryl K (2007). This study has found smart pump technology to be of limited benefit as it intercepted only 4% Iv-ADEs. The IV-ADEs incidence rate with conventional pump was 4. 78 per 1000 patient-day and 4. 95 with smart pump (p = 0.

96). This insignificant result was attributed to the fact that a few ADEs matched smart pump features. As mentioned earlier, smart pump has dose limit established as either soft and/or hard limits depending on the DERS

program. Hard limits are set of restriction that cannot be overridden. Soft limits are simply limits that can be overriding by nurses.

It is design to give some flexibility to the doctors. In Carolyn K study (2005), there was 88% overriding cases. Also, in P L Trbovich study (2010), when the nurses faced with soft limit alerts, many of them elected to overridden it. This result draws the attention to the human violation that can affect the pump optimum performance and may precipitate medication errors and thus affect patient safety. It is important to check the causes of such practice and if necessary, to make change in the limits according to the need.

In regard to pump programming accuracy, P L Trbovich study (2010) found that there was no difference in the program accuracy across pump types for task requiring continuous infusion (p> 0. 1), but when the task required some calculations by the nurse to programming the traditional pump (in case of intermittent infusion), the smart pump and barcode pump entries were more accurate than the traditional one (p0.

1) and adverse events resulting from secondary infusion errors were not preventable by smart or barcode technologies. Most of these errors were due to human mistakes like positioning the therapeutic drug bag at or below the level of the maintenance fluid bag which result in concurrent delivery of the therapeutic and maintenance fluids or confusion in the programming sequence. Some studies showed that, smart pumps help in providing doctors by continues accurate data about what had been given to the patient (Gitte Y, 2005) and that smart pumps with CQI (continues quality improvement) help in tracing, recording the programme error and near miss which will help

in find out the causes of this error and in setting a plan to avoid or prevent it by improving the process of administration and thus increase the patient safety. Based on the comparative speed of implementation, smart pump is more rapid, easy to implement and low in cost comparing to CPOE and barcode system (Carolyn K, 2005; James A, 2002). Only two studies have found smart pump technology with limited benefit (P L Trbovich, 2010; Teryl K, 2007).

The reason of this finding from first study was human factors (overriding) rather than pump design while in the other study the ADEs did not match the used pump features. All other studies emphasized that smart pumps are valuable in preventing errors and increasing the patient safety. Add to that the nurse compliance with safety software which was 98-100% which is very important in using of this technology (Carolyn K, 2005). Many errors were intercepted by smart pumps such as: incorrect high rate, incorrect low concentration and low rate, 10-fold error in dosage, calculation errors, duplicate medication. However, some errors could not be detected by smart pumps used such as: wrong patient, wrong dose or rate (when still within pump limit) and failure to intervene. Some of the studies identified in this literature review have some limitations.

In P L Trbovich study (2010), the two main limitations were the small number of participation in this study and that it held in patient care simulation. This raises a question if these results may be generalized to true patient care setting where there is overload and interruption. However, this article showed the types of errors for which smart pump and barcode are effective. In Jeffrey M (2005) and Teryl K (2007) were done in ICU and so the results

came may not be generalized to other units. In James A study (2002), the main limitation were the small sample size been examined, and the articles did not show data (in numbers) for the improvement in the practice after uses of smart pumps. However this study was a good example for systemic planning, selecting and implementation of technology in order to improve the health system.

Lastly, in Gitte Y study (2005), the limitation was the small number of data been analyzed in comparison to the study duration (2 years) which indicated underreporting. Also, in this study as they did three concurrent changes in their practice (use of smart pump, standard drug concentration and redesigned labels); it is difficult to conclude the impact of each change in reducing IV infusion errors. However, it was a good example for best practise in order to minimized errors. All of the studies been included in this review were funded either by ministry of health of study country or by the institutions where the study been done which cancel any chance of bias. Conclusion: The complex nature of intravenous medication administration required the use of technology.

Smart pumps are one of the technologies identified that hospitals can used to help reduce the frequency and severity of medication errors. However, it is not enough to implement the smart pump, set up the drug libraries, educate and train the staff to get the maximum benefit of this technology. It is important to continuo review reports and log analysis data in regular base in order to identify the defect or problems that prevent the maximum benefit of these pumps. From this literature review, it is clear that in order to have the best practice improvement with smart pump use, hospitals can do the

following: Expand the smart pump features in order to increase the capability of the pump in detecting wide range of administration errors. Expand the drug libraries with continuous review and remodel it according to the hospital needs. The use of hard limits to prevent unsafe rate or dose.

Monitor and measure the nurse compliance with this technology so as to remove any barriers toward appropriate use of smart pumps. In addition to that, the ingoing education and training. Standardized concentration and dosing units will help in reducing errors emerge from this side. As much as possible, the hospital should standardise the type of smart pump used among different hospitals units in order to simplify nurse training, reduce programme complexity and increase ease of use. More research should be done to find out the benefit of integrating smart pumps with other technologies (like CPOE, Bar-code system) in reducing the incidence of medication errors and increasing the patient safety.