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**Insulin utilisation pattern and its cost in managing diabetes mellitus for ambulatory patients in Miri Hospital: A two-year comparative study**

Shirlie Chai<sup>1</sup>

<sup>1</sup> *Pharmacy Department, Miri Hospital, Sarawak*

Corresponding author name and email: Shirlie Chai ([shirlie\\_chai@yahoo.com](mailto:shirlie_chai@yahoo.com))

**Abstract**

**Introduction:** Diabetes mellitus is a chronic disease and insulin is one of the treatment available irrespective of diabetes type. The prevalence of diabetes is escalating in most parts of the world, including the low- and middle-income countries. The purpose of this study was to explore the insulin utilisation pattern and its' cost for ambulatory patients in Miri Hospital from 2016 to 2017.

**Methods:** Information on insulin dispensed from January 2016 to December 2017 was extracted from Pharmacy Information System, exported to Microsoft Excel and analysed. The cost was retrieved from the procurement records for various purchasing channels. The utilisation pattern was described as the quantity and percentage of insulin dispensed based on types of insulin. The cost was calculated by multiplying the quantity of insulin dispensed with unit cost obtained from the procurement records.

**Results:**

All insulin available in our hospital was included in the analysis. The insulin was categorised based on the types and pharmacokinetics profile. The most common insulin dispensed was premixed conventional insulin, followed by short-acting insulin and intermediate-acting insulin. However, the long-acting insulin analogue consumed the vast portion in term of cost expenditure, followed by premixed conventional insulin and short-acting insulin.

**Conclusion:**

This study found that insulin utilisation increased for all categories of insulin studied. It was showed that unit cost of insulin plays an important role in insulin utilisation pattern for ambulatory patients in our hospital. Future research should aim to associate the insulin utilisation patterns to clinical and economic outcomes in managing DM.

**Keywords:** *Utilisation, insulin, diabetes mellitus, cost, Malaysia*

## Introduction

World health Organization (WHO) estimated that noncommunicable diseases (NCDs), including diabetes mellitus (DM) lead to mortality of 36 million people annually at present (1). According to WHO, the prevalence of diabetes in 2014 has ascended from 108 million to 422 million over the past 34 years (2). Moreover, the disease burden is escalating more rapidly in low- and middle-income countries (2). The National Health & Morbidity Survey (NHMS) 2015 reported that the prevalence of known DM and undiagnosed DM in Malaysia are 8.3% and 9.2% respectively. The prevalence increases from 11.6% in 2006, 15.2% in 2011 to 17.5% in 2015. Among the known diabetics, 25.1% claimed to be insulin users in NHMS 2015 (3).

Diabetes mellitus is a chronic disease, which could be caused by autoimmune selective destruction or dysfunction of beta cells of the islets tissue in the pancreas, as in Type 1 DM (4). It is entirely insulin-dependent; hence patients would require lifelong exogenous insulin. Nonetheless, Type 2 DM is caused by relative loss of beta cells mass and/or its secretory defects and it constitutes the most major share of diabetic cases (4). When metformin monotherapy is inadequate to achieve optimum glycaemic control, another drug should be initiated (5). Insulin is an option, however, other oral antidiabetic agents are preferable in practice. It is recommended that in patients with HbA1C > 10.0% or fasting blood glucose > 13 mmol/L, metformin with insulin therapy is the first-line treatment (6). A generally stricter target is employed in gestational DM (7). Hence, this study includes insulin which is one of the most common modalities irrespective of diabetes type. It is thought that the study result pertaining to insulin would be of great interest to healthcare professionals in Malaysia.

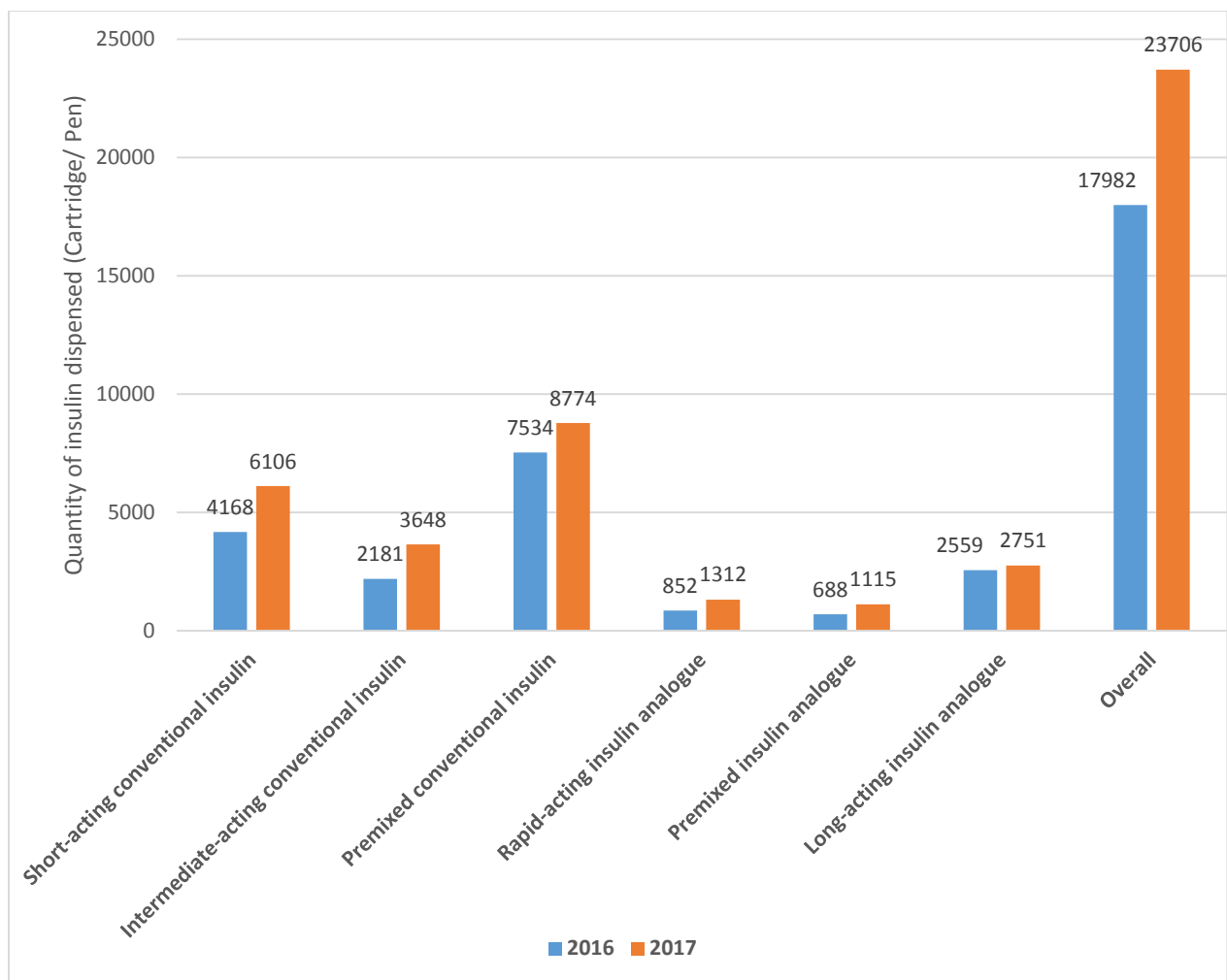
Policy makers have embarked on the implementation of information and communications technology (ICT) enabled facilities, as one of the moves to progressively adopt and deploy Information communication “Technology in Health Care” in facilitating the coordination of medical care. This study is among the pilot attempt to extract data from Pharmacy Information System (PhIS), which is ICT system currently used in Miri Hospital, particularly in the management of medication prescribing, dispensing and administration. The purpose of this study was to explore the insulin utilisation pattern and its cost in Miri Hospital from 2016 to 2017.

## **Methods**

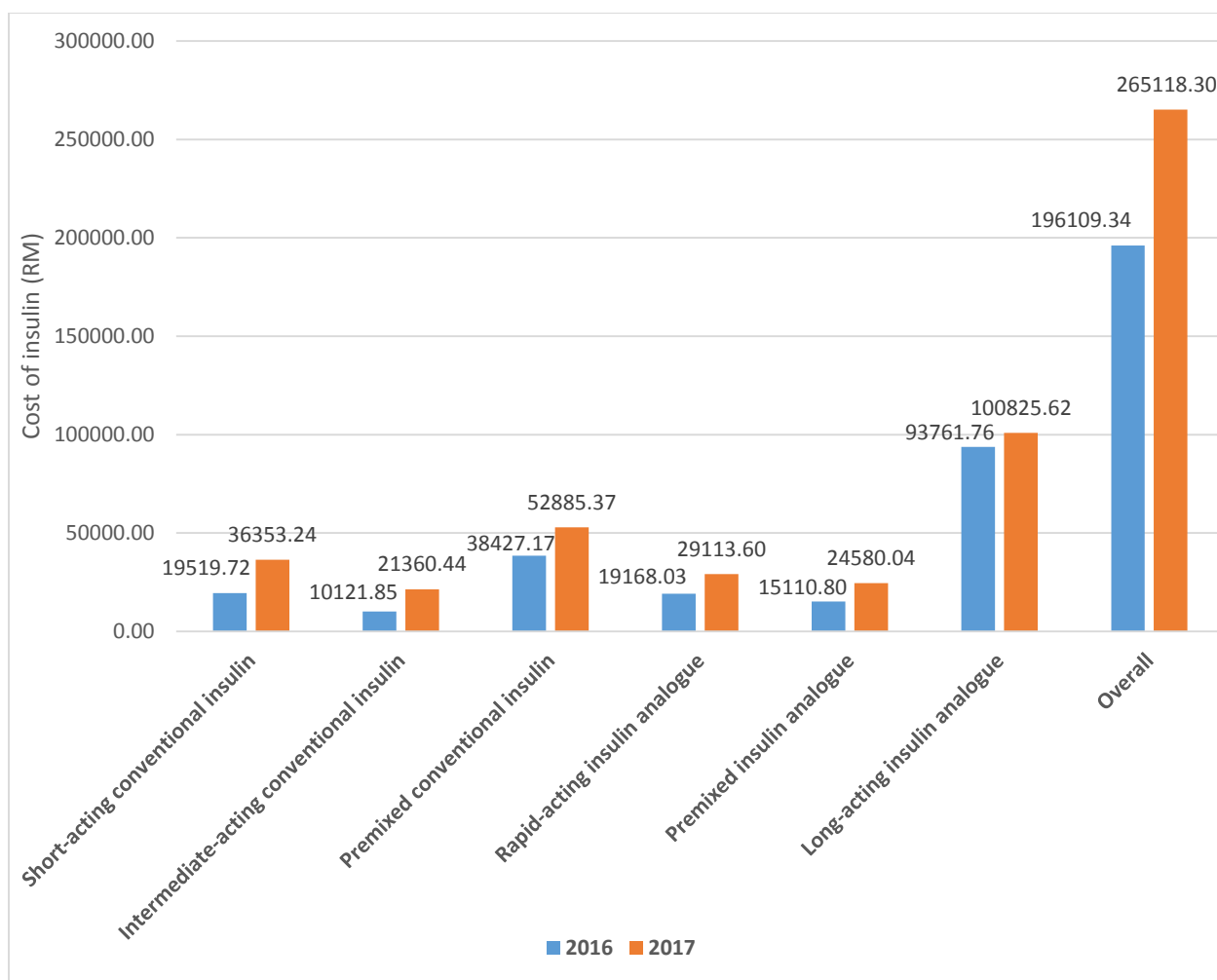
This is a retrospective observational study. Information on insulin dispensed from January 2016 to December 2017 was extracted from PhIS, exported to Microsoft Excel and analysed. Data extraction was made in December 2018. The cost was retrieved from the procurement records for various purchasing channels. Descriptive statistics were conducted. The utilisation pattern was described as the quantity and percentage of insulin dispensed based on types of insulin. Meanwhile, the cost was defined as the sum of expenditure in Ringgit Malaysia (RM) for the respective insulin per year. The cost was estimated by multiplying the quantity of insulin dispensed with unit cost obtained from the procurement records.

## Results

All insulin available in our hospital was included in the analysis. The insulin was categorised based on the types and pharmacokinetics profile. The most common insulin dispensed was premixed conventional insulin, followed by short-acting insulin and intermediate-acting insulin. However, the long-acting insulin analogue consumed the vast portion in term of cost expenditure, followed by premixed conventional insulin and short-acting insulin. Figure 1 summarised the utilisation pattern of insulin while the cost in Figure 2. Details of insulin dispensed based on its brand name and type are shown in Table 1.



**Figure 1.** Utilisation pattern of insulin



**Figure 2.** Cost of insulin

**Table 1.** Quantity of insulin dispensed and its cost in 2016 and 2017

| Insulin                                         | 2016                            |              |                  |              | 2017                            |              |                  |              |
|-------------------------------------------------|---------------------------------|--------------|------------------|--------------|---------------------------------|--------------|------------------|--------------|
|                                                 | Quantity<br>(Cartridge/<br>Pen) | %            | Cost (RM)        | %            | Quantity<br>(Cartridge/<br>Pen) | %            | Cost (RM)        | %            |
| <b>Short-acting conventional insulin</b>        | <b>4,168</b>                    | <b>23.18</b> | <b>19,519.72</b> | <b>9.96</b>  | <b>6,106</b>                    | <b>25.76</b> | <b>36,353.24</b> | <b>13.71</b> |
| Insulin regular (Actrapid)                      | 21                              | 0.12         | 111.76           | 0.06         | 614                             | 2.59         | 3,151.05         | 1.19         |
| Insulin regular (Insuman Rapid)                 | 4,147                           | 23.06        | 19,407.96        | 9.90         | 891                             | 3.76         | 4,169.88         | 1.57         |
| Insulin regular (Insugen-R)                     | 0                               | 0.00         | 0.00             | 0.00         | 4,601                           | 19.41        | 29,032.31        | 10.95        |
| <b>Intermediate-acting conventional insulin</b> | <b>2,181</b>                    | <b>12.13</b> | <b>10,121.85</b> | <b>5.16</b>  | <b>3,648</b>                    | <b>15.39</b> | <b>21,360.44</b> | <b>8.06</b>  |
| Insulin isophane (Insulatard)                   | 65                              | 0.36         | 345.93           | 0.18         | 329                             | 1.39         | 1,688.43         | 0.64         |
| Insulin isophane (Insuman Basal)                | 2,116                           | 11.77        | 9,775.92         | 4.98         | 752                             | 3.17         | 3,474.24         | 1.31         |
| Insulin isophane (Insugen-N)                    | 0                               | 0.00         | 0.00             | 0.00         | 2,567                           | 10.83        | 16,197.77        | 6.11         |
| <b>Premixed conventional insulin</b>            | <b>7,534</b>                    | <b>41.90</b> | <b>38,427.17</b> | <b>19.59</b> | <b>8,774</b>                    | <b>37.01</b> | <b>52,885.37</b> | <b>19.95</b> |
| Insulin regular/isophane (Mixtard-30)           | 17                              | 0.09         | 90.47            | 0.05         | 703                             | 2.97         | 3,607.80         | 1.36         |
| Insulin regular/isophane (Insuman Comb)         | 7,517                           | 41.80        | 38,336.70        | 19.55        | 1,364                           | 5.75         | 6,956.40         | 2.62         |
| Insulin regular/isophane (Insugen-30/70)        | 0                               | 0.00         | 0.00             | 0.00         | 6,707                           | 28.29        | 4,2321.17        | 15.97        |

**Table 1.** Quantity of insulin dispensed and its cost in 2016 and 2017 (*con't*)

| Insulin                                                     | 2016                            |               |                   |               | 2017                            |               |                   |               |
|-------------------------------------------------------------|---------------------------------|---------------|-------------------|---------------|---------------------------------|---------------|-------------------|---------------|
|                                                             | Quantity<br>(Cartridge/<br>Pen) | %             | Cost (RM)         | %             | Quantity<br>(Cartridge/<br>Pen) | %             | Cost<br>(RM)      | %             |
| <b>Rapid-acting insulin analogue</b>                        | <b>852</b>                      | <b>4.74</b>   | <b>19,168.03</b>  | <b>9.77</b>   | <b>1,312</b>                    | <b>5.54</b>   | <b>29,113.60</b>  | <b>10.98</b>  |
| Insulin aspart (Novorapid)                                  | 752                             | 4.18          | 17,175.68         | 8.76          | 1,090                           | 4.60          | 24,895.60         | 9.39          |
| Insulin Lispro (Humalog)                                    | 31                              | 0.17          | 681.35            | 0.35          | 0                               | 0.00          | 0.00              | 0.00          |
| Insulin Glulisine (Apidra)                                  | 69                              | 0.38          | 1,311.00          | 0.67          | 222                             | 0.94          | 4,218.00          | 1.59          |
| <b>Premixed insulin analogue</b>                            | <b>688</b>                      | <b>3.82</b>   | <b>15,110.80</b>  | <b>7.71</b>   | <b>1,115</b>                    | <b>4.70</b>   | <b>24,580.04</b>  | <b>9.27</b>   |
| Insulin aspart 30%/aspart protamine<br>70% (NovoMix-30)     | 412                             | 2.29          | 9,138.16          | 4.66          | 836                             | 3.53          | 18,542.48         | 6.99          |
| Insulin lispro 25% /lispro protamin<br>75% (Humalog Mix-25) | 166                             | 0.92          | 3,592.24          | 1.83          | 164                             | 0.69          | 3,548.96          | 1.34          |
| Insulin lispro 50% /lispro protamin<br>50% (Humalog Mix-50) | 110                             | 0.61          | 2,380.40          | 1.21          | 115                             | 0.48          | 2,488.60          | 0.94          |
| <b>Long-acting insulin analogue</b>                         | <b>2,559</b>                    | <b>14.23</b>  | <b>93,761.76</b>  | <b>47.81</b>  | <b>2,751</b>                    | <b>11.60</b>  | <b>100,825.62</b> | <b>38.03</b>  |
| Insulin glargine (Lantus)                                   | 2,559                           | 14.23         | 93,761.76         | 47.81         | 2,688                           | 11.33         | 98,488.32         | 37.15         |
| Insulin detemir (Levemir)                                   | 0                               | 0.00          | 0.00              | 0.00          | 63                              | 0.27          | 2,337.30          | 0.88          |
| <b>Overall</b>                                              | <b>17,982</b>                   | <b>100.00</b> | <b>196,109.34</b> | <b>100.00</b> | <b>23,706</b>                   | <b>100.00</b> | <b>265,118.30</b> | <b>100.00</b> |

**Table 2.** Percent change in quantity dispensed and cost from 2016 to 2017

| <b>Insulin</b>                           | <b>Percent Change in<br/>Quantity (%)</b> | <b>Percent Change in<br/>Cost (%)</b> |
|------------------------------------------|-------------------------------------------|---------------------------------------|
| Short-acting conventional insulin        | 46.50                                     | 86.24                                 |
| Intermediate-acting conventional insulin | 67.26                                     | 111.03                                |
| Premixed conventional insulin            | 16.46                                     | 37.62                                 |
| Rapid-acting insulin analogue            | 53.99                                     | 51.89                                 |
| Premixed insulin analogue                | 62.06                                     | 62.67                                 |
| Long-acting insulin analogue             | 7.50                                      | 7.53                                  |
| <b>Overall</b>                           | <b>31.83</b>                              | <b>35.19</b>                          |

## Discussion

Global disease burden of DM is increasing (2). In line with increasing DM prevalence, the overall healthcare expenditure had been on the rise (8). As the similar trend in DM prevalence had been reported in Malaysia (3), the rising use of insulin is expected. Quantity dispensed in our hospital had increased by 31.83% from 17982 cartridges/pens to 23706 cartridges/pens. Concentration of insulin is similar for all the insulin, 100 IU/ml and volume for each cartridge/ pen is 3 mL. Similar trend had been observed for all categories of insulin.

In the local setting, conventional human insulin is often the preferred choice of insulin due to its cost and availability. In our hospital, a number of the insulin analogues are restricted items with special request needed. However, a greater increase in insulin analogue, namely the rapid-acting and premixed insulin analogue, as compared to their counterpart conventional insulin, short-acting and premixed conventional insulin was observed. This may be due to its profile which mimics physiological endogenous insulin secretion, convenient administration time and lesser risk

of hypoglycemia. Hence, they have gained more popularity nowadays. However, it is interesting to note that long-acting insulin has the smallest increase in quantity dispensed (7.50%), compared to the largest hike in intermediate-acting insulin (67.26%). The latter was preferred probably due to the high cost of long-acting insulin, which is about six times the intermediate-acting insulin.

Alongside the increase in DM prevalence, insulin initiation had been diversified in recent years. The old-fashioned approach in managing Type 2 DM is the slow-paced lifestyle modification, diet, exercise, weight reduction, oral antidiabetic agents and, finally, insulin therapy. However, the focus of current treatment strategies has been revised. In recent practice guidelines, approach to insulin initiation, optimization and intensification have been given more attention (6, 9). Current guidelines recommend earlier use of insulin therapy in patients who present with sub-optimal glycemic control or with failure of oral antidiabetic agents. Recent reviews recommended that early intensive insulin regimen has the potential to preserve and protect the beta cell function in Type 2 DM before progression to profound beta cell failure (10-12).

Meanwhile, the expenditure on insulin had grown at about 35% in the second year. The largest change in price was observed for short- and intermediate-acting conventional insulin, 86.24% and 111.03% respectively. The change is significant in comparison to their quantity changes, 46.50% and 67.26% respectively, contributed by the surge in unit cost of conventional insulin by 35% in 2017, in addition to the rise in their usage.

### **Limitation and Recommendation**

This study observed an increase in the insulin utilisation. According to several local audits, despite the availability of many options in insulin therapy, few patients attain glycaemic control and only 10-15% patients treated with insulin achieved good glycaemic target, as measured by HbA1c of < 6.5% (9). Nevertheless, the current study did not address patient characteristics at baseline during insulin initiation, clinical and economic outcome of insulin therapy, hence these are the possible direction for future study.

### **Conclusion**

This study found that insulin utilisation increased for all categories of insulin studied. It was showed that unit cost of insulin plays an important role in insulin utilisation pattern for ambulatory patients in our hospital. Future research should aim to associate the insulin utilisation patterns to clinical and economic outcomes in managing DM.

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