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Vol: 1, Issue: 1

Journal of Pharma and Pharmaceutical Sciences

The Effect of Using Pictograms on Comprehension of Medical Information- A Meta-Analysis

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Article Type: Research, **Submission Date**: 16 March 2015, **Accepted Date:** 23 May 2015, **Published Date:** 11 June 2015.

Citation: Sonal G Mansukhani (2015) The Effect of Using Pictograms on Comprehension of Medical Information- A Meta-Analysis. J.Pharm Pharm Scien 1(1): 22-32. doi: https://doi.org/10.24218/vjpps.2015.05.

Abstract

This is a meta-analysis to study the effect of using pictorial aids on medication packaging and inserts on the comprehension of medication related information. Health literacy is a growing concern amongst health care systems globally. Research has demonstrated that people with low or marginal levels of literacy have lesser knowledge about their condition and understand "text-only" medication instructions inaccurately. Building on such findings, incorporation of illustrations in the form of pictures have been thought of and studied to improve some of the outcomes related to medication understanding. This meta-analysis aimed to synthesize and analyze data from such studies and unveil avenues for further research which can prove to aid interpretation of medical information via such visual aids. Studies included in this analysis used a specific treatment intervention which comprised of medical information provided as text in conjunction with pictograms, and compared this to a text-only intervention which was treated as the control. All the patients in these studies were randomized to both the interventions. They received medical information in the form of patient label; patient information leaflets (PILs) or consult demonstration by a healthcare provider. Meta-analysis was performed using random effects model. Results supported the primary hypothesis of pictograms aiding in medical comprehension with a $p<0.0001$. The summary effect size was found to be $g = 0.5$ [0.19, 0.8]. The I^2 value for this omnibus test was almost 88%, implying a huge amount of heterogeneity in the sample. Amongst the moderators tested, number of years of education was found to be close to significance ($p=0.09$) and the type of visual aid used was not significant ($p=0.87$). This analysis could not assess the type of literacy testing because of the lack of standardized testing using tools like REALM or TOFHLA in the included studies. Further, efforts should be made in order to understand how pictograms affect medical comprehension with a follow up to achieve tangible outcomes such as medication compliance and adherence.

Introduction

Communication between the healthcare providers and patients has been known to be inefficient and ineffective [1]. Care-providers often use technical language to explain the situations to the patient as there is no other best way to explain the situation to the patient. The use of such medical jargon further potentiates the problem of understanding from the perspective of the patient, as they get preoccupied by their symptoms. This makes the patients concentrate even lesser to the terminology used by their care providers [1].

Studying the various factors which may affect the rate of understanding information, literacy levels of patients have been found to be strongly associated with the level of understanding of information [2]. The reading skill level of the average adult citizen of the United States is estimated to be the 8th to 9th grade level [3]. Contrast this with the fact that more than half the written health care instructions recently surveyed have readability levels at 10th grade or higher [4-6]. Therefore health educators are trying to simplify the language and present the information in forms which would be readily comprehensible to the patients. "Health literacy" is a concept which was gained a lot of momentum in the late 1980's when researchers started realizing that their proposed interventions were being moderated by another variable called health literacy of the individual. The Patient Protection and Affordable Care Act of 2010, Title V, defines "health literacy as the degree to which an individual has the capacity to obtain, communicate, process, and understand basic health information and services to make appropriate health decisions".[7] Health care organizations such as hospitals, clinics, pharmacies, are making special efforts to gauge the health literacy of their target customers and tailor interventions based on such measures for the most optimal solution [7,8].

Presenting information in the form of pictures and illustrations has been studied as an alternative or in conjunction with textual information. In fact, this concept of presenting information in the form of pictures is a prehistoric phenomenon through stone-age cave drawings and Egyptian hieroglyphs.

There are several names given to define the presentation of information in ways which are not textually designed. These could be icons, logos, ideograms, pictographs and pictograms [9]. It is important to understand the differences between these different forms of illustration-representations for avoiding misuse and deciding how and when to use them. An icon is an image or a statue which could be of significance either religiously or culturally. These icons are being used very commonly in all kinds of screen based technologies such as websites, software and phone applications. Icons have also found good use in aiding communication about medication instructions. In a randomized controlled trial involving heart failure patients, the intervention group was allotted written directions in the form of icons for each medication category [10]. The purpose of the icons to aid in patient knowledge of understanding and accurately identifying which prescription is for which of their diseases. The judgment on how the information needs to be disseminated by the pharmacist, i.e. the use of the icon-medication instructions versus regular text directions were on the discretion of the pharmacist. The study found an improvement in the adherence rates of cardiovascular drugs in low-literacy indigent populations; however the effects could not be attributed to the icon- medication instructions as the intervention involved multiple components [10]. A logo is a branding representation depicting a specific organization. An ideogram is a graphical symbol that represents an idea, rather than a group of letters arranged according to the phonemes of a spoken language, as is done in alphabetic languages, for example a symbol of a setting sun combined with the symbol for a man could communicate old age or death. Pictographs are the drawings which represent the instructions for an action [11]. A two-series study tested the incorporation of pictographs in a variegated sample of literate and low-literacy patients. The measurement outcome was recall of medical instructions after at two time points- immediately after training and four weeks after training. Pictograms have been defined as a "stylized figurative drawing that is used to convey information of an analogical or figurative nature" [9]. Pictograms form a part of our daily lives through their prevalence during transport, managing computer –related information and even on our phones for better communication. As described in the literature, pictograms have several advantages; they can be interpreted more accurately and faster than words, they serve as "instant reminders of a hazardous messages, lastly, they serve as excellent sources of information for people with compromised vision (or even proximity to textual information), people with limited literacy for the language which is dominant geographically.

Literature on the use of pictograms to communicate health related information is replete with patient outcomes such as improved patient understanding of explicit directions to use their medicines [2]. Research with different patient groups has demonstrated the usefulness of pictograms in improving comprehension, when compared to text only information [11-13]. Some of the earlier works in pictograms have demonstrated improved acquisition and comprehension of information presented in patient information leaflets [2]. In a survey study which assessed the use of pictograms in patient information leaflets, 74.3% (out of n=1000) found that the use of pictograms was useful to find helpful information [13]. Further, this study found to what extents five pictograms can be used for depicting information pieces such as "side effects", pediatric use, use in pregnancy"and"dosage. The responses were not very favorable to use pictograms for "therapeutic indications" and "contraindications". Literature has also demonstrated that various methods of evaluating the effect of pictograms and the context in which they are evaluated bears a huge value on the evaluated outcomes [11,14,15]. In a study in literate adults, comprehension of information which was presented in the form of pictograms improved after training people on how to use the pictograms. Further, post training effects of the pictogram were also more stable and sustainable over time, something which is a struggle in improving comprehension using such instructions [14]. In another study which tested the comprehension of pictograms in children found that the proportions for correct interpretations ranged from 30-99%, however the importance of the context was given a lot importance. The study concluded that pictograms in the context of medical information, perhaps in patient information leaflets or on actual prescription labels will increase the usefulness of the pictograms in terms of understanding of information [15].

Therefore, it is important to study how pictorial information is perceived by the end-users of this information. Further, it is important to identify areas of literature which can be used to build more accurate information and optimally use the inclusion of pictograms as a substitute for text-based information.

A meta-analysis is an intelligent way to gauge the summary effect of the interventions pooling all the research which is out there around this topic of pictograms and medication comprehension. As per the knowledge of the author, no meta-analysis has been done on this topic before this attempt. Hence this lends great importance to the healthcare community.

Theoretical Perspective

Paivio's dual coding theory (DCT; Paivio, 1986, 1991; Sadoski & Paivio 200) argues that equal weight should be given to verbal and nonverbal processing, because presenting information in both visual and verbal form enhances recognition and recall [16]. The theorists recognize the presence of logogens and imagens which run parallel in the minds of people. He argues that the simultaneous co-existence of these micro-codes would help in aiding comprehension and active learning.

McGuire's information processing theory can also be used to explain the basis for this intervention linking to comprehension [17]. The processing theory recognizes that there are five input variables (source, message characteristics, channel, receiver and response target) and 13 output variables (exposure, attention, liking, comprehension, cognitive elaboration, skill acquisition, agreement, memory, retrieval, decision making, acting on the decision, cognitive consolidation, and proselytizing). Figure 1 will explain how the theoretical model fits and helps us in understanding how pictures can be used for processing information.

As can be seen from the model, the characteristics of a message have the potential to influence how the message gets received and processed by the receiver. Pictures fall in the message characteristics segment of McGuire's inputs as it is a way in which the message is being transmitted across to the receiver. On the other hand of the outcomes section, lies comprehension of this message. Therefore, this theoretical model fits perfectly in line with the research study in question.

Other models such as Christopher Wicken's model for human information processing and memory can also be used for

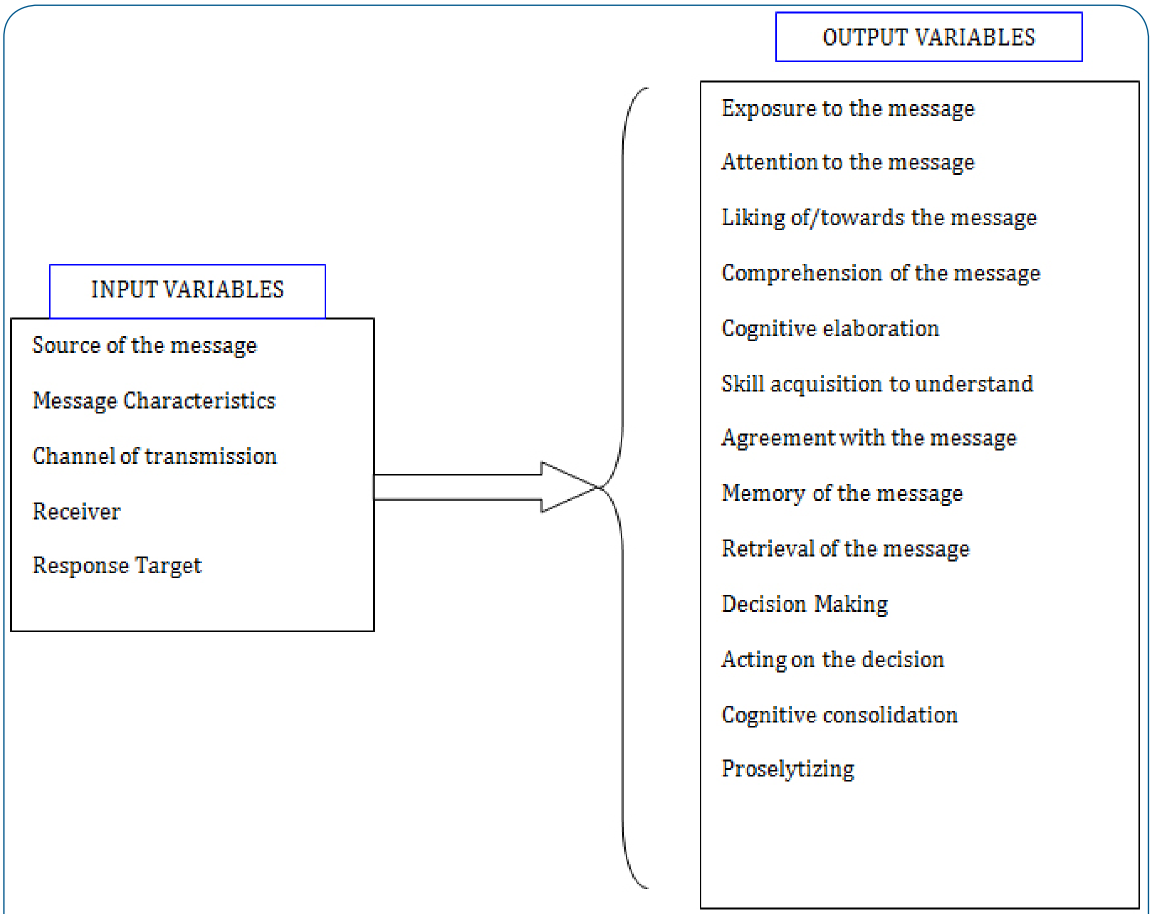

Figure 1: McGuire's Information Processing Model

explaining the use of pictograms for aiding understanding of medication related information [18]. This model argues that the short term memory or the working memory of the brain is the most dynamic part of the brain. After the stimuli have been received and processed by the brain, the working memory works in tandem with the long term memory to develop and deliver an appropriate response to the stimuli. Pictograms, pictures and other illustrations could be used to explain the difference in perception if medication related information is found, when being compared to text only information.

Yet another model, the Communication-Human Information Processing (C-HIP) Model, has been studied extensively for research regarding effective warning signs [19]. This model uses a combination of McGuires' simple communication model which talks about the sender which transmits a piece of information towards the receiver. Based on the characteristics of the information, the receiver is then able to pay attention to the message, comprehend the message, form an attitude or a belief about the message, is either motivated or non-motivated towards performing a specific behavior in response to the original message. In the context of this study, pictures can be used as a form of message transmission and the hence how pictorial messages associate a behavior of medication comprehension can be studied.

Methods

This meta-analysis aimed to answer the following question: How does incorporation of pictograms in conjunction with textual information aid in medical comprehension of patients? Figure 2 explains the meta analysis.

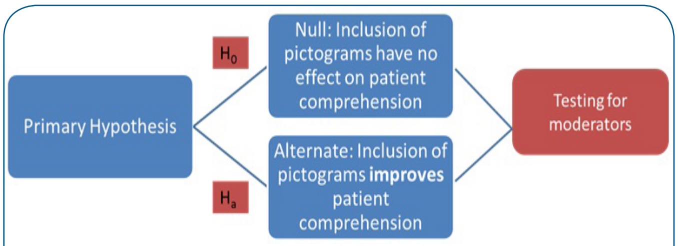

Figure 2: Research Question for the Meta Analysis

The independent variable (IV) for this meta-analysis is the presence of pictograms or other kinds of imagery to facilitate the comprehension of medical information. The IV is operationalized as general instructions with pictograms, cartoon images or directions of medication administration in different templates. The dependent variable is the extent of medication comprehension which has been operationalized using different measurement scales which are self-reported. These measurement scales used anywhere between four to twelve questions to measure "comprehension." These questions can be categorized into questions pertaining to recall, information accuracy and confidence in administering the medications as indicated.

Figure 3 represents the flow of studies from various sources:

*Keywords used to tap into databases for literature review included:

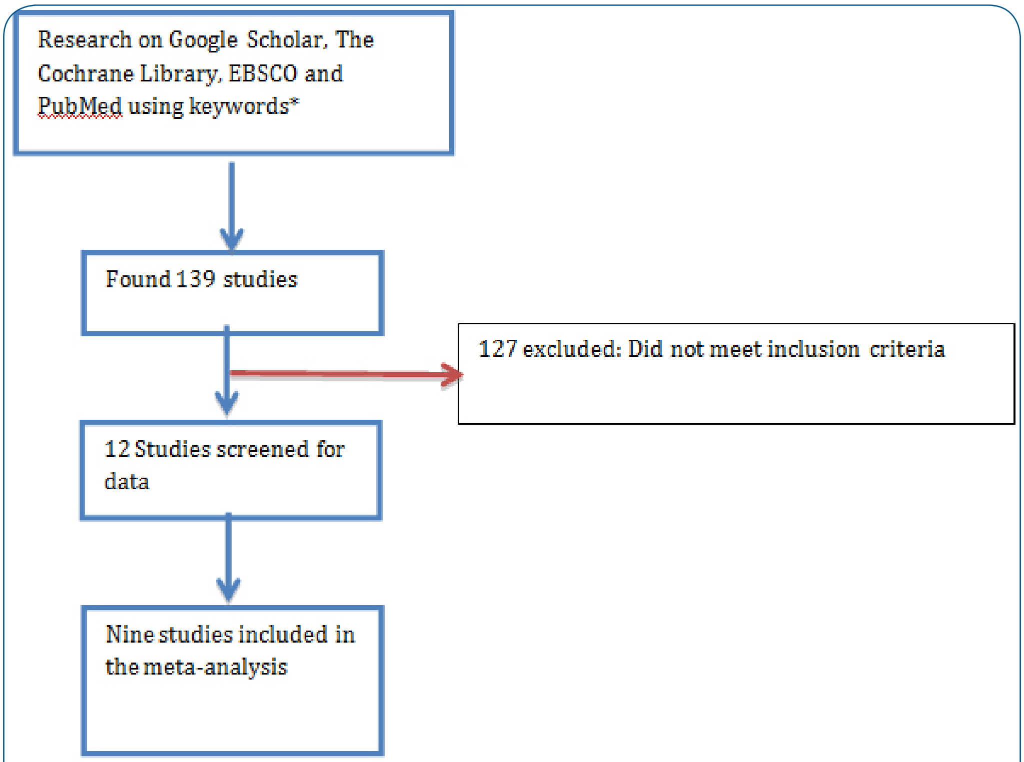

Figure 3: Flowchart for inclusion of studies

- Pictograms and health literacy
- Visual aids and health comprehension
- Imagery in prescription labels

Different Boolean combinations of AND/OR operators was used to make the literature review comprehensive.

Inclusion criteria for the review were that the intervention had to include pictograms in conjunction with text, together being compared to the control arm which would contain only textual information. The studies had to assess comprehension of medical information as the only or one of the outcomes. The subjects had to be randomly allotted to one of the arms. Further, the studies should have been published no earlier than 1995. Only English language studies were screened for and hence included in the analysis. In conclusion, nine studies were extracted from an initial pool of 139 studies and provided the data for the meta-analysis.

Selection of Studies

The nine selected studies evaluated the effect of pictures with text on comprehension of health information. As mentioned earlier, comprehension was assessed using recall, understanding and accuracy of medication related information. This analysis aims to synthesize and analyze data from all such studies and unveil avenues for further research which can enhance interpretation of medical information via visual aids. No a-priori knowledge or any pre-conceived systematic technique was used for selection of the studies. All studies which met the inclusion criteria were included.

Description of the Studies

The following paragraphs will describe the studies in detail.

Mansoor and Dowse assessed the effects of incorporating pictures on understanding medication instructions among 80 patients receiving chronic HIV/AIDS cotrimoxazole therapy in South Africa [20]. Subjects were randomly assigned to experimental and control groups and asked to read a patient information leaflet. The experimental group's leaflet included pictures while the control groups did not. Subjects were later asked questions about how much they recalled and understood this information. Mansoor et.al demonstrated medical comprehension in another study with HIV/AIDS patients. The understanding towards randomly allocated PILs was assessed after 14 days of handing over [21].

Delp and Jones assessed the effect of cartoon illustrations on patient comprehension of emergency department release instructions. 234 patients were randomized to receive ED instructions with or without cartoons. The comprehension assessment was performed telephonically after three days [22].

Yin et.al conducted a narrow spectrum randomized controlled trial to test the efficacy of a pictogram based health literacy intervention to decrease liquid medication administration errors in 245 caregivers of young children in an emergency department. Errors were linked to lack of medication comprehension and hence were included in this meta-analysis. Comprehension was assessed using two different sub-groups with differences in the type of medication being taken [23].

Dowse and Ehlers recruited 87 out-patients to determine the influence of medicine labels incorporating pictograms on the understanding of instructions. These were randomized to receive medication with pictograms on the label along with textual information, as an intervention. Follow up visits to understand instructions were conducted after five days [24].

King et.al conducted a randomized trial to test short term recall of pharmacy-generated prescriptions in a low-literate population. This study was administered the intervention in a unique fashion. All participants were asked by the interviewer to assume (pretend) that they were receiving a prescription by a pharmacist for an unfamiliar medication to treat a personal medical condition. The follow-up questions by the interviewer were asked after a minute of handling the leaflet [25].

In another study by Hwang et.al, commonly used illustrations were paired with textual information and assigned to out-patients of an urban teaching hospital in Canada. This study was based on non-random assignment and judged short-term recall of the correct interpretations of the labels [26].

In a study by Weymiller et.al, Type2 Diabetes Mellitus patients were randomized to receive a visual image-enhanced decision aid, and based on the level of comprehension of this aid, they were evaluated on their treatment decisions. Comprehension was assessed immediately post the visit which provided an opportunity for the endocrinologists to randomly allocate the intervention to 98 patients [27].

Ngoh and Shepherd conducted a randomized trial in 78 female ambulatory patients. The intervention was a "culturally-sensitive" visual aid designed to help convey drug information to non-literate female patients who were on anti-biotic prescriptions [28].

Design of all studies

Figure 4 depicts the patterns of interventions for the studies used.

Moderator Analysis

The moderator variables for a meta-analysis include all the factors which could potentially have an impact on the effect size of each of the studies. Research has established that the level of literacy plays a crucial role in comprehension of information [2]. Therefore, literacy level of the patients stood out as one of the most important moderator variables. Further, studies included different proportions of gender in their sample; hence gender was the second potential moderator for the analysis. Other moderators included the type of visual aid used, the geography of the study and mean age of subjects. These were in line with previous research which has tested such moderators.

Two coders were used to code for the moderators. Both the coders were PhD students in the University of Wisconsin-Madison and had the same number of years of experience in the field. The other coder had similar qualifications and training in order to code for studies. The two coders consulted each other frequently for clarifications on study-specific items however all coding disputes were clarified at the end of the coding cycle. Eventually, inter-coder reliability was established with an average Kappa measure of 0.652. A kappa measure of over a 0.5 is considered to be a moderate level of agreement. Table 1 gives an overview of the moderators which were coded.

Amongst the moderators coded, measure of comprehension was coded for values which referred to recall and degree of comprehension, based on the kind of analysis which was present in the included studies. The type of comprehension test was different for each of the studies. Follow up ranged from 1 minute

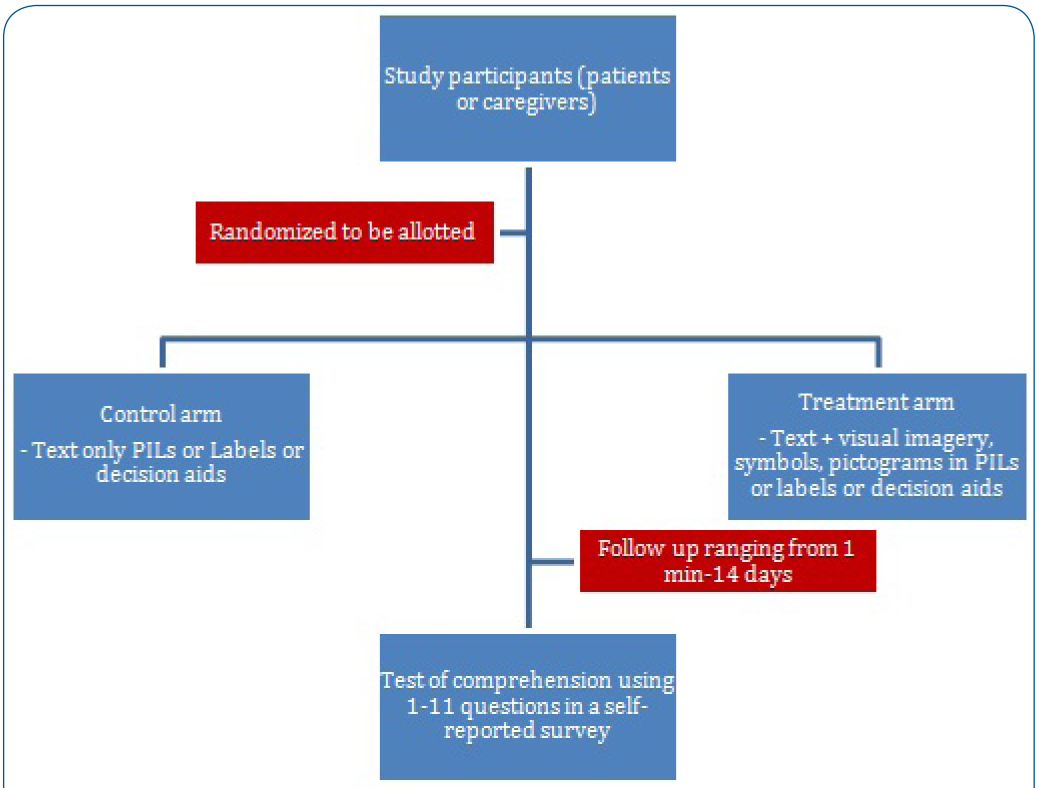

Figure 4: Design and description of studies

Table 1: Types of moderators which were coded

Study Characteristics	Location of the study Number of arms Number of participants Honorarium provided
Sample Characteristics	Mean age %Female Highest qualification by majority Type of patients
Intervention Characteristics	Disease type Duration of therapy Route of therapy Number of drugs being tested Measure of comprehension Time to follow up for measurement to treatment Type of visual aid used

to 14 days. This can be particularly important to discern as research has demonstrated the impact of the test method and the context in which the testing is done is sensitive to the variations in outcomes such as recall and comprehension.

Statistical Methods

Extraction of effect sizes

The chosen nine studies were evaluated for the *kind* of statistical interpretation which has been provided for each study. Four out of nine studies (Mansoor and Dowse, Yin et al, Hwang et al, Mansoor et al) used odds ratio (OR) computations to demonstrate effect. Three studies (Delp and Jones, Dowse and Ehlers, King et al) used means and standard deviations to indicate their results. Two studies (Weymiller et al and Ngoh et al) reported exact p values which were converted to Cohen's d after computing t values. Data presented in a continuous form were converted to means and standard deviations and then converted to Cohen's d. The Cohen's d values from all studies was then corrected for sampling bias and converted to g values. The following formulae were used to carry out the computation in Microsoft Excel (Table 2).

Comprehension was operationalized using a survey which used questions associated with readability, recall and basic understanding. As there was no standardized form for assessing comprehension, separate effect sizes were calculated for each of the parameters which were assessed. Therefore, effect sizes ranged from 1-11 per study. The sample was divided in two categories based on the kind of medication they were at (daily dose or as-needed) and hence separate effect sizes for two different sample numbers were calculated from this study. A single file with the studies and their computed effect size values in terms of g and Var(g) was made. This file was fed into R (and Mad package) with R Studio (version 3.0.1) statistical software for aggregation of the effect sizes in order to get one effect size for each study sample. Running a meta-analysis on the aggregated data, a significant Q was found ($p<0.0001$) and hence this analysis warranted for testing moderators to explain the heterogeneity which existed in the dataset. R (and Mad package) with R Studio (version 3.0.1) statistical software was used for moderator analysis as well.

The following moderator tests were conducted in relation to the dependent variable; effect of average years of education on medical comprehension, effect of the type of visual aid employed for testing medical comprehension, effect of gender on medical comprehension, effect of course of therapy for which visual aids were used to predict medical comprehension, effect of mean age of the patients on medical comprehension, effect of geography of the study on medical comprehension, effect of follow-up of testing comprehension.

If the moderators were clearly represented in studies, then they were coded by taking the average of the control and the experimental group. However, this was rarely the case as different moderators were presented in a different manner in each study. Average literacy level was judged by the number of years of education completed by the sample population in each of the arms in the study. Yin et al, was the only study which provided an average number of years of education for their control group and experimental group. Other studies computed average years of education in different categories of grades and number of high school years. High school was considered to be up till the age of 17 years for the population. Studies which categorized their samples into continuous grade values were converted to their mid points, and the average was calculated for both the arms individually. Studies such as King et al, Hwang et al, Weymiller et al, and Ngoh et al, presented their data in categories of "greater than or less than high school". The categories for such data were divided based on the average age of the subjects in the study. For example: >High school was rewritten as 18-28 years of education if the mean age of the participants was 32 years and 4 years was considered as the start date of school. This method of computing average years of education may not be the best estimate of the actual population education years; however it is the closest to computing a summary effect for this moderator. Hence, this moderator was coded as a continuous moderator.

Visual aids were classified into prescription labels, patient information leaflets. Most of the information which was provided to the patients in the study using patient information leaflets. In two studies, the information was provided as a consult to the

Table 2: Generation of a Cohen's d to g

Odds ratio to g and Var(g)	Computed OR- Log OR using LN() Var(LOR) = 1/A+1/B+1/C+1/D LOR to d= ((LOR)*SQRT(3))/PI() Var(d) = ((3*Var(LOR))/PI()^2) J =1-(3/(4*(n-2)-1)) g= J*d Var(g) =J^2*Var(d)
Means to g and Var(g)	Compute standard deviation within the sample using =SQRT(((N_t-1)*s.d_t^2 + (N_c-1)*sd_c^2)/(N_t+N_c-2)) d=($Mean_T$ – $Mean_c$)/sd_{within} Var(d)= (N_T+N_C)/(N_T*N_C) + d^2/(2*(N_T+N_c)) J=(1 - 3/(4*(N_T+N_C-2)-1)) g=J*d Var(g) =J^2*Var(d)
Exact p values and t values reported in studies to g and Var(g)	If t values were not provided, it was computed in MS Excel using TINV(p/2,n-1) d= t*SQRT(1/n) Var(d) = ((1/n)+(d^2/2*n)) J=(1 - 3/(4*(N_T+N_C-2)-1)) g=J*d Var(g) =J^2*Var(d)

patients and was preceded by a primary explanation which may have influenced the comprehension of the patients. This was coded as a categorical moderator.

Research has shown that duration of therapy can have a huge impact on the level of medical comprehension [16]. Hence, this was coded on two levels- acute therapy and chronic therapy. Duration of therapy was coded as a categorical moderator. The experience of drug therapy was not included as a moderator because of the lack of its explicit statement in our included studies.

Mean age of the participants was calculated from the studies using simple average from the two arms. There were two studies which tested the effects of providing imagery in prescription information to a mixed batch of pediatric patients and their caregivers. In these cases, the results of the study would have certainly been biased as the level of education of the caregiver would be much different than the other education levels. This was coded as a continuous variable.

Follow up to test the level of comprehension was conducted in two ways- testing short term recall (Hwang et al and King et al) in which the patients were given the visual aid and asked for the correct interpretation of the information. Second method was more robust and tested the degree of comprehension post intervention ranging from 3-14 days. This was coded as a continuous moderator.

Moderator analysis was conducted in R Studio using two different packages: MAd and metafor. Different commands were used for analysis and plotting of data depending on the type of moderator in analysis- Continuous or Categorical.

Results

Nine studies were included in the meta-analysis. The description of the studies can be found in Table 3.

The first step in the analysis was to meta-analyze the effect sizes which reflect a comparison of treatment and control means which have been randomized to receive the intervention.

Nine studies produced a total of ten aggregated effect sizes. The omnibus test was run on these studies and a summary effect size of $g_+ = 0.42$ was obtained for the pool of studies. This could be recognized as a moderate effect size according to Cohen's benchmark for effect sizes. The 95% CI [0.13, 0.70] does not include 0 and hence this effect size is significantly different from 0. This suggests that an inclusion of pictograms significantly enhances comprehension of medical information. The I^2 values reported below describe the percentage of leftover variance which is not attributed by sampling error. This gives us room to explore our moderators and how much of the variance can be accounted for out of this 85% variance.

By looking at the forest plot (Figure 5), we can distinguish different effect sizes pertaining to different studies.

Table 4 demonstrates the effect size of the outcome.

The significant Q statistic as shown in the table above warrants our moderator testing from Table 4. Starting from the study characteristics, of particular interest was the location of the study as the pool of studies had a mix of African, US and Canadian studies. Since there was only one study from Canada, it made sense to code the study with the US, as their comprehension operations are really close, and what could be achieved out of this analysis was to establish a difference between comprehension of

Table 3: Description of studies with intervention characteristics

Study name and year of publication	Number of participants	Description of population and intervention	Measure of outcome	Results
Mansoor et.al 2007 [20]	80	HIV/AIDS patients were randomized to pictograms on PILs.	Comprehension via recall	Mean % for knowledge was significantly higher in the intervention group that received the simple PIL incorporating pictograms (76.3%), compared with both the text only control Group (43.3%)
Delp and Jones 1996 [22]	234	ED discharge cartoon illustrations on patients with slight injury. PILs.	Comprehension via recall and understanding	The intervention group which was given cartoon instructions were more likely to have read the instructions (98% vs 7996, p $\leq$ 0.001), were more likely to be accurate in wound care questions (46% vs 6%, p < 0.001). This group was also more compliant with daily wound care (77% vs 54% p $\leq$ 0.01)
Yin et.al 2008 [23]	245	Parents or caregivers of children prescribed liquid medication. PILs	Medication knowledge and practice (errors), dosing accuracy	Intervention group had significantly lesser medication errors than the “routine care” group. Improvement in knowledge and frequency of daily prescribed doses- more accurate in intervention group.
Dowse et.al 2005 [24]	87	Outpatients given treatment labels	Understanding of instructions	Presence of pictograms was found to lead to high adherence (>90%) for 54% of the experimental group as compared to 2% in the control group.
King et.al 2012 [25]	108	Hypothetical assignment assumption for treatment intervention via PILs	Recall and accuracy	Symbols were not found to enhance the recall and accuracy of information between the intervention and the control groups.
Dowse et.al 2006 [20]	80	Outpatients with HIV/AIDS on cotrimoxazole. PIL	Comprehension on understanding and recall	Pictograms significantly improved adherence to therapy in the short term. A non-significant increase in adherence was associated with the availability of more complex information.
Hwang et.al 2005 [26]	130	Consequent control and treatment labels. Non randomized trial. Labels with symbols.	Recall	The addition of illustrations was associated with improved performance in 5–7% of subjects and worsened performance in 7–9% of subjects.
Weymiller et.al 2007 [27]	98	Diabetic patients randomized to receive a decisional aid on choice towards cardiovascular drugs, PILs used	Knowledge about outcomes and risk aversion	Significant differences in knowledge and accuracy of estimated cardiovascular risk and had lesser decisional conflict.
Ngoh and Shepherd 1997 [28]	78	Outpatient female populations given culturally sensitive PILs	Understanding and accuracy of information	Comprehension and compliance scores were significantly higher in the experimental group than the control group.

the patients in Africa and the developed countries. Hence, this was coded as a categorical predictor and moderator analysis was performed. Similar categorical moderator analysis was performed with the kind of therapy- acute or chronic, for which the drugs were taken and the type of visual aid used for testing medical comprehension. The results for visual aid and literacy levels were of particular interest and hence have been explained in great detail here. The moderator analysis for the other variables, as mentioned in the methods section, was found to be insignificant with medication comprehension.

The type of visual aid used is of particular interest to me as medication labels are stuck on the medication bottle and are much more handily visible to patients. On the other hands, patient information leaflets may be provided inside the medication bottle or handed over at the time of visit to the hospital. As a result, it may be misplaced or kept unattended. When the moderator analysis was conducted on this categorical variable, no significant contribution to the parent heterogeneity was made. The following box-plot (Figure 6) illustrates the differences between labels and PILs used as visual aids on the effect size. The insignificant findings could be attributed to the fact that there were only two studies which used labels to test medical comprehension. PILs were tested in seven of the nine studies and there was a significant difference found in between these seven studies (p=0.005), however the moderating effect on the type of visual aid on the effect on pictograms was not significant (p=0.87).

Amongst the continuous moderators which were tested for

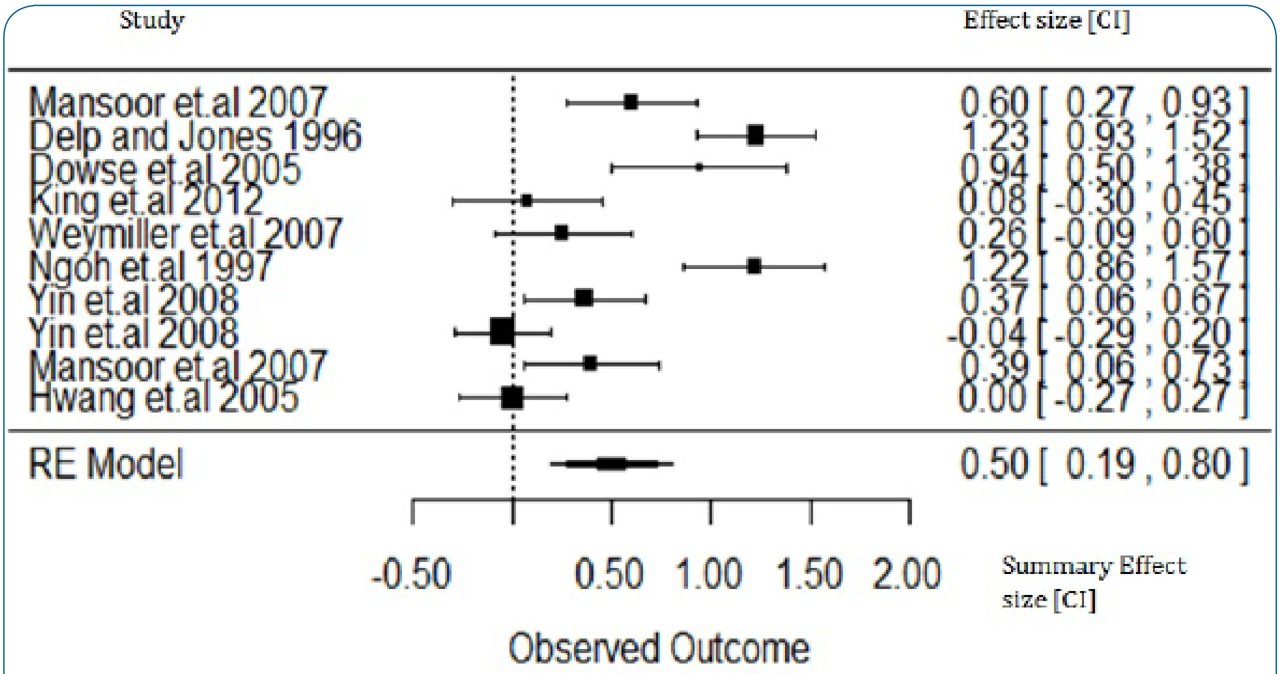

Figure 5: Forest Plot of the effect sizes of the studies included

Table 4: Meta-analysis of pre-post effect sizes for control groups, for the dependent variable

	k	g+	95% CI	Q	p	I2
Medical comprehension	10	0.50	[0.19, 0.80]	81.66	<0.0001	88.98%

Note: Studies were modeled as random effects, k = number of studies, d+ = effect size (standardized mean change from pre-treatment to post-treatment); Q = homogeneity test; p = probability value for Q statistic under H0 (df = k-1); I2 = percentage of variance in effect sizes that is attributable to systematic variation.

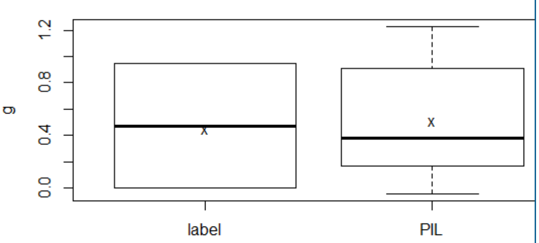

Figure 6: Box plot of visual aids as a moderator

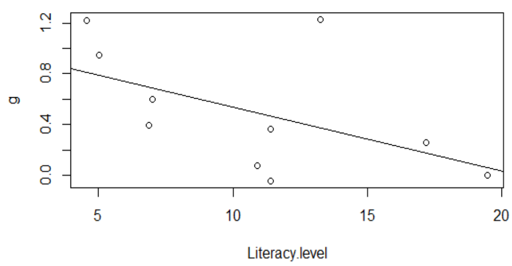

Figure 7: Scatterplot of the continuous moderator-Literacy Level

contribution to variance, the literacy level of the patients was of particular interest. The following scatterplot (Figure 7) describes the effect of increasing literacy level on the study effect size. This scatterplot shows a negative correlation: Studies with more educated participants tended to report smaller effect sizes. This validates the results provided by earlier research which stresses how pictograms are most useful in comprehending medical information for population which is low in literacy (Table 6).

Discussion

Based on the results of this, it can be concluded that pictograms do indeed enhance comprehension of medical knowledge. Despite strong evidence of heterogeneity among study effect sizes, the moderators which were tested did not reach statistical significance. This is not surprising given the relatively small number of studies available for analysis. In case of literacy level, two studies (King et.al and Hwang et.al) showed that pictograms were, infect not found to be of significant effect in aiding medical comprehension [25,26]. This perhaps could be explained by the population which was chosen for the study and the methods of conducting the study. King et.al asked the patients to assume that the PIL is given to them for a particular medication, by a registered pharmacist [25]. They were then ask to comprehend the PILs with pictograms and textual information and tested on accuracy of content. This method would fail to be externally valid as the patients are not going through the same trauma and stress of having to deal with the symptoms of the disease, for which the medication is to be prescribed. Moreover, they only chose outpatients who would not be having the same gravity of disease as the in-patients might have. Hwang et al used a non-

Table 5: Meta-analysis of moderator analysis- Visual Aids a categorical moderator

	k	g+	95% CI	Q	P	I2
Type of Visual Aids						
Labels	2	0.4456	[-0.28,1.17]	12.77	0.2282	92%
PILs	8	0.51	[0.15,0.86]	66.12	0.0053	89%

Table 6: Meta-analysis of moderator analysis- Literacy Level a continuous moderator

	estimate	Se	Z	P	CI.lb	CI.ub
Intercept	1.0452	0.3638	2.884	0.004	0.3342	1.7563
Education	-0.0508	0.0307	-1.6536	0.0982	-0.111	0.0094

Test of Moderator: QM(df = 1) = 2.7345, p-val = 0.0982

randomized way to allot their intervention [26]. Further, the intervention was first explained to the patients with the correct interpretation of the pictogram, and short-term recall was tested for patients soon after.

Amongst other limitations to this meta –analysis, data extraction process could be streamlined, if the authors of the studies provided and presented relevant data appropriately. Further, databases on Human factors and Ergonomics, along with the proceedings of conferences, abstracts, books, and manufacturers were not taken into account. The number of years of education was presented in categories such as “>high school”, “<high school”. This information was coded as a continuous variable, with “>high school” to range from 18 years until the average age of the patients in the sample.

It would behoove researchers to view the data if standardized literacy scores such as those provided my REALM (Rapid Estimate of Adult Literacy in Medicine) or TOFHLA (Test of Functional Health Literacy Assessment (TOFHLA*)* could be used for patients. So far, studies have relied on surrogate measures of health literacy such as the ones mentioned above. These standardized tests could help in decreasing the number of assumptions and estimates in the study and predict actual results. While education is important, it is known that education level alone cannot appropriately determine an individual’s health-literacy skill and more moderators which predict health literacy need to be discovered [29].

Amongst other moderators which can be tested in this context, ethnic group could be an important variable. Although the study sample was picked from an extremely diverse set of studies for this meta-analysis, ethnic group was not tested as a variable as it is assumed to be highly correlated with health literacy. The standards for comprehension and the levels of literacy for Black populations are strongly associated. Therefore, it could be thought that this might have a co-linearity effect on data analysis, and bias the data. Further, since the studies were drawn from different geographies, it would not be compatible to put the Black population from South and West Africa with the Black population in America. However, the association between the two different Black populations could be an interesting judgment.

Studies have demonstrated that viewers with low literacy tend to understand the intended message much better, if the pictures are represented in a simple fashion without too many distracting details. Dowse et.al 2006 have recommended that that when a sequence of pictures is being used, limited text written as closely possible to the sequencing works the best in aiding comprehension [20].

As the results of the intervention have not been consistent throughout research, it is advisable to use an evaluation of the systematic effects of the pictogram interventions in the form of follow up interviews with differing durations of time, and not just merely stopping at short-term recall and understanding. Different measures of comprehension have been used to assess comprehension. These spectrums could be tapped into to assess which aspects do how well for different kinds of patients. Pictures should be clearly represented and not have ambiguity or missing information.

Future research should aim at solving the disparities on the use of pictograms for increasing medical comprehension. This research should not only be applied to address medical comprehension, but should be percolated into more tangible outcomes such as reduction in medical errors or improving medication adherence.

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