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Review Article

A review of CDSCO's guidelines on Recall and rapid Alert system for Drugs

Shrikanth Pulparambil* G Siddappa Shanthakumar

Department of Pharmaceutical Regulatory Affairs, Acharya & BM Reddy College of pharmacy, Soladevanahalli, Hesaraghatta Bengaluru-560107.

Abstract

The Central Drugs Standard Control Organization (CDSCO) ensures that all the pharmaceutical products are subjected to rigorous testing for its safety and efficacy before it is marketed. As per WHO, the existence of false claim medications, spurious, false labeled products that are freely produced and forged, packed with false labeling or misbranded is a trend growing worldwide. Drug recalls are carried out on severely defective drug products which can cause health risks to the patients by voluntarily by manufacturers or by the mandate of CDSCO. Recall guidelines are well established in India with a focus on recall classification, recall assessment and management, steps taken to increase rapport between manufacturer and CDSCO regarding recalls. Timelines to carry out any class of recalls are specified in their guidelines. This article aims at reviewing the CDSCO's Guidelines on Recall and Rapid Alert System for Drugs including recall classification, procedure, and levels of recall, recall evaluation system, timelines, and follow up actions.

Keywords: Recall, Mock recall, Rapid alert system, DCGI, CDSCO, Pharmacovigilance.

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*Corresponding author Tel.: +91-9448735274;
E-mail address: dra.skumar2018@gmail.com (P Shrikanth).

1. Introduction

A recall of drugs is the most productive and effective means of ensuring public safety by protection against a faulty or drug that can be potentially dangerous. According to CDSCO "Recall is an action taken to withdraw/remove the drugs from the distribution or use including corrective action for which deficiencies are reported in quality, efficacy or safety. The defective products related to quality include Not of Standard Quality, Adulterated or Spurious drugs." it also includes drugs that are prohibited for market release under the Drugs & Cosmetics Act and those products carrying a suspended/canceled product licenses. The procedure involves the return of a batch or an entire unit production of a drug product, mostly when the concern is regarding the safety of the produced drug due to drug safety issues or if there is any fault in the product during its production. Given the best efforts the company tries to produce and deliver healthy and genuine drugs, there is still the risk that dangerously faulty drugs can enter the customer market. A recall is a costly undertaking, even if patient safety is not at stake, not only in terms of apparent costs but also in terms of reputation and the risk of litigation. (1)

Rapid Alert System is incorporated for the transmission of only particular alerts which are very serious and of utmost urgent and cannot be permitted for any sort of delay in transit of alert. Assessment of alert to be performed shall be carried out concerning the degree of the defect, its possibility of causing any harm to the patient or animals (veterinary product), consumers, operators (medical device), and effect on the environment.

The CDSCO is the national regulatory body that overlooks every aspect of Indian pharmaceuticals and medical devices. The organization is headed by the Drug Controller General of India (DCGI). Under the supervision of the Ministry of Health and Family Welfare, the CDSCO carries out regulation of all the aspects beginning from the discovery to the market release including post-market surveillance of pharmaceutical and medical devices. The DCGI performs his duty under the advice of the Drug Technical Advisory Board (DTAB). The Drug Consultative Committee (DCC) is an advisory committee that provides awareness to the Central and the State Government on any matter that tends to ensure consistency throughout the administration of the Drugs and Cosmetics Act. The DCC guidelines have ensured

the categorization of 'Not of Standard Quality' (NSQ) drugs as Category A and Category B defects and have given separate action to be taken on NSQ drugs based on defect category. (2)

Guidelines on Recall and Rapid Alert System for Drugs (including Biologicals & Vaccines) published in 2012 is valid to every report on quality defective product and incidents reported on the safety and efficacy received through post-marketing surveillance for drugs vaccines and biological. This guideline must be followed by a license holder throughout the supply chain of the defective product for voluntary or statutory recalls in India. Both Central and State Drugs control authority follows the procedure during any threat to public and animal health has occurred due to the product as a result of which an immediate recall is necessary. This guideline ensures a stepwise procedure to be implemented by the manufacturer in the recall of a product, strategy to be followed for recall evaluation at every level, and timelines permitted to achieve compliance.

2. Recall classification

According to this guideline, classification of recalls are done numerically, roman numerical I, II or III, are assigned to a product recall based on the relative degree of risk imposed on to the safety of the product by the CDSCO. All Drugs & drug Products that are prohibited for sale and those drugs whose license is suspended or canceled and which is in market circulation shall also be considered a Class I only recall.

- **Class I** recalls are enforced in case of most serious reasons, for example - class I recalls are enforced when there is a defect with a drug as a result of raw material contamination, or faulty labeling of the product that could apparently lead to serious health problems including even death.
- **Class II** recalls are enforced when there is an exposure to the drug which has a potential to cause a temporary or reversible health problem or which carries a slight chance of a serious problem.
- **Class III** recalls are enforced on products subjected to violation of regulation – for example a container that does not carry the number of pills on the label – but these reasons are unlikely to result in any adverse health consequences.

3. Types of recall

Any product or an entire batch of a product that fails to comply with the defined quality standards will be recalled from the market circulation. (3)

There are two types of recall procedures; Voluntary Recall and Statutory Recall.

Voluntary Recall

Any incident which might alter the quality and safety can launch a voluntary recall. It can be done on a Batch/product where efficacy is in question, such as

- If the batch or batches fails to comply with the set regulatory requirements during the Post-market stability study
- During market complaint investigation if the batch is found to be defective
- During an investigation, if a lack of investigation is observed that might harm the quality of the batch which is already released into the supply chain.
- During a visual inspection, if any unusual observations are noted related to the retention samples indicating a negative impact on the product quality post-investigation.
- If any reports from post-market surveillance /pharmacovigilance indicate that there is a serious safety risk associated with the product in circulation.

Statutory Recall

The statutory recall will be enforced as a response to the instruction or mandate by the Drug Regulatory Authorities both Central and State under the following situations.

- Recall of any product/batch that is subjected to a violation of the law hence labeled as not of standard quality, etc.
- All recalls of banned/prohibited drugs.
- Violation of the law regarding Labeling and/or promotional materials used in the manufacture
- Any product that falls under Product infringement Rule 106 (Diseases referred in Schedule J)

Recall letter

If the company performs any recall activity, the license holder must prepare a recall letter which gives an evidential statement about the reason for recall along with other information that helps easy identification of the product in the market. It must include a detailed description of the drug product and the potential risk associated with the product. The letter must also contain instructions regarding the recall procedure with emphasis on return, disposal, and refund strategies. This letter has to be forward to every level of distribution. (4)

4. Levels of recall

The determination of level (or depth) of the product/batch recall shall be done considering the recall Classification and the extent to which the distribution of such product has taken place. According to this guideline, there are three levels of recall which are consumer/user level recall, retail level recall, and wholesale level recall. (5)

- **Consumer-level recall:** This includes individual patients, physicians, and hospitals and will require action to be taken on behalf of the consumer, such as returning medication to the retail store for a refund or calling a special hotline number on the product label for more assistance.
- **Retail-level recalls:** Enforced at retailers and providers which includes retail groceries, independent pharmacies, hospital pharmacies,

physicians involved in dispensing, clinics and nursing homes, etc.

- **Wholesale-level recalls:** This involves the recall of the product from a distribution between the manufacturer and retailer.

Annexure-1 of QA-GNL-021
'CLAA-Specimen Letter for Recall of Not of Standard Quality Batch of Vaccine'

Central Drugs Standard Control Organization
Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India
FDA Bhavan, ITO, Kotla Road, New Delhi -110002

ORDER TO STOP SALE OR DISTRIBUTION OR USE OF DRUG & RECALL NOTICE

FILE NO.: .....

TO, **DATE:** .....

< Name and Address of the Licensee >

This is to intimate you that *< Name of the Product----------, Batch No. -------, Date of Manufacture----------, Date of Expiry----------, Manufactured By M/s (Name of the Manufacturer and address----------)>* has been declared by *< Name of the Laboratory---------->* as not of standard quality; vide *< Letter/Report Number ..... dated ..... >* for the reasons that *<reasons to declare the product as NSQ---------->* declared as NSQ whose copy is enclosed for your reference. The above drug has reported to be causing serious adverse events /death.

You are, therefore, directed to stop distribution, sale or use of above mentioned drug and to initiate its recall from the market. Also you are directed to submit details within ---------- hours/days as per recall class ----------to this office as per the enclosed formats.

(Signature, Name and Address of CA/SLA)

Copy for information and necessary action to:

1. The State Licensing Authority of all the States/UTs of Union of India for action to stop distribution, sale or use of above mentioned drug in their jurisdiction.
2. The Zonal or Sub-Zonal Office of concerned CDSCO.

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Figure 1. Recall letter

5. Timelines for effective recall system & rapid alert:

Categorizing by evaluation of risk involved, Class I recalls is given a time-limit of up to a maximum of 72 hours, a maximum of 10 days is allowed for Class II recalls and Class III recalls are allotted up to a maximum of 30 days to carryout recall activity. The timeline for ceasing the sale/distribution of any defective products that fall under Class I shall be enforced within 24 hours and the physical recall activity shall be completed within 72 hours. Recalls for Class II and Class III have allotted a timeframe of up to 10 and Up to 30 days respectively. (6)

Alert procedure

Every recall should follow a unique strategy; many factors are common in every recall procedures. These common factors must be considered before the company comes up with an appropriate strategy for the recall. Consideration has to be given on informing the officials and factors that may affect the duration of the recall process. The strategy should include an efficient alert system to ensure every stage on the supply chain is aware of the recall hence further distribution/circulation of such goods is stopped. (7)

- On immediate identification of product/batch to be recalled is done, the license holder or authorized representative of the license holder or the Quality Assurance (QA) in charge shall carry out the review of information regarding the defective product/batch and decide on the recall in compliance with the procedure established procedure.
- Within 24 Hours but not exceeding 72 hours, a decision to recall the circulating product/batch shall be taken for Class I recall after total review of information
- Once the decision is taken to recall the product/batch (s) Within 24 Hours information shall be sent stating the degree of the defect, incorporating the rapid means of communication that may include email, telephone, fax, SMS, etc. to the entire supply chain.
- When the product is already placed on the market, the license holder / authorized representative of the licensee must inform the regulatory authorities concerned about the distribution of the product batch(s) in question immediately following the decision to recall. Further recall actions will be undertaken as per the recall class.
- The classification of the product/batch subjected to recall shall be done based on a risk assessment in compliance with the classification of recall as defined in the guideline
- The responsibility to inform the retailer of the reason for the recall is of the manufacturer and the marketing company through its freeze notification.
- The stock position of the product being recalled has to be informed to the supplier or manufacturer and also the Drugs Inspector by the distributor /marketing company/dealer.
- All the records relating to the recall notification received the stock at that time, the procedure for the freezing of the stock and the return shall be maintained by the distributor/retailer and should be made available for any verification by the Drugs Inspector area, who shall verify and report on its timely freezing and return.

6. Recall procedure

- The license holder/authorized representative shall note down the details and enter it into the Recall log. Upon completion of the entry, a unique reference number is assigned. The number must represent the year of the recall.
- To prevent further distribution of the product, the license holder/authorized representative should pass on the information on all levels of the distribution chain. Information regarding the current stock available has to be collected and return procedure has to be passed on.
- As a mandated procedure the distributers should receive a Product Recall Notice by the license holder/authorized representative.
- On receiving such notice the distributors should check their distribution recorded as to trace the product flow and should identify all the customers, retailers, and warehouses where the distribution has taken place. They should also send a copy of the recall notice and inform them of any further action.
- Further from the depot, the notification letter filled and signed by the head of the depot is forwarded to all distributors stating to return of all stocks available.
- The Return Feedback is filled by the distributor and sent back to the depot along with goods. These goods from the depot are then forwarded to the company warehouse.
- The license holder/authorized representative shall receive a timely report on the available stock in the warehouse and all the received goods. This process of information transfer must be done on the supervision of the head of the warehouse.
- Products withdrawn for reconciliation have to be recorded.
- Care has to be given for the fulfillment of recall procedure within the allowed timeframe depending on the class of recall and on successful completion of the procedure the head of the warehouse shall fill in the Summary Report of Product / Batch Recall.

Follow-up action of recalled goods

The follow-up action is very necessary as the company has to perform a root cause analysis of the quality defect. They have to take a quick decision on what can be done on the recalled products and to what extent the procedure of recall was successful, The procedure consists of evaluating the effectiveness of the recall conducted, launching an investigation to identify the reason for recall and preventive actions to be taken to ensure there is no recurrence of such defect. (8,9)

- The monitoring of the recall conducted has to be carried out by the license holder/authorized representative / QA Head to determine if the recall process was satisfactory or not.
- All the products recalled shall be kept under 'Quarantine' which is stored in a separate area that Is secured with lock and key until a decision is taken on what can be done to the products.

Annexure-2 of QA-GNL-021
'Recall Log'

Central Drugs Standard Control Organization

Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India
FDA Bhavan, ITO, Kotla Road, New Delhi -110002

RECALL LOG
(To be filled in by licensee / representative of licensee)

Recall ref. no.	Time & Date of recall Initiation	Product name	Batch ./ Lot No	Mfg Date	Exp Date	Reason for recall	Classification [Class I,II,III]	Quantity Produced / B. Size (A)	Unsold or Undistributed quantity in possession (B)	Quantity Distributed (C)	Quantity Returned / Recalled	Closure Date & Sign.	Remarks

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Figure 2. Recall Log

Annexure-3 of QA-GNL-021
'Recall Notice to Distributors/Marketing company/Stockist/Retailers'

Central Drugs Standard Control Organization

Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India
FDA Bhavan, ITO, Kotla Road, New Delhi -110002

RECALL NOTICE TO DISTRIBUTORS / MARKETING COMPANY / STOCKISTS / RETAILERS

Part A: (To be filled by licensee / representative of licensee)

To;	Recall Ref.No.: ..... Date:.....

Please stop further distribution/sale of below mentioned product/batches with immediate effect. Kindly recall the stocks of these batch/es from the market. All unsold goods in the warehouse and recalled goods to be quarantined till further advice.

Product Details (Name/Strength/Dosage/Pack)	Batch/ Lot no.	Mfg. date	Expiry date	Batch Size	Quantity released for sale

Type of recall: (Tick as appropriate) Statutory/ Voluntary

Recall classification: Class I Class II Class III

Extent of recall : WH Depot Distributors Retailers Authorized Exporter (in case of exports)

Hospitals/Healthcare Professionals/Consumers Agents in importing countries

Reason for recall:

Licensee / representative of licensee
(Name, Sign & date)

Manufacturing site: ..... Mfg.Lic.No.: .....

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Figure 3. Recall Notice

Annexure-4 of QA-GNL-021
'Summary Report of Recall'

Central Drugs Standard Control Organization

Directorate General of Health Services, Ministry of Health and Family Welfare, Government of India
FDA Bhavan, ITO, Kotla Road, New Delhi -110002

SUMMARY REPORT OF RECALL

Part A: To be filled by Distributor / Retailer as applicable

Recall Ref. No.		**Date:**		
Product name				
Batch no.		**Mfg Date:**		
Reason for Recall				
Name of Customer	**Qty. Received on purchase invoice (A)**	**Quantity Sold (B)**	**Quantity Un distributed / Stock in Hand (C)=(A)-(B)**	**Quantity Received from Customer in response to recall (D)**
Total Quantity	(G)=	(H)	(E)	(F)
Stock not distributed (E)				
Quantity available in Warehouse after Recall (E+F)				
Total quantity received with purchase invoice (Purchase Invoice No., Date, etc.)(G)				
Justification for any Deviations observed During reconciliation				
Stock / Sale License No.				
Prepared by: Retailer / Wholesaler (Personnel Sign/Date)				

Part B: To be filled by manufacturer

Batch Disposition:	Quantity:..... to be; Destroyed Reprocessed	Batch Size: Reworked Any other (specify)

Recall Summary:
(Also mention, action taken if product was still available for sale or use)

Licensee / Representative of licensee

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Figure 4. Summary Report of Recall

- Initially, a physical examination is conducted on the recalled goods by the QA Head of the manufacturing site and a sample is taken to investigate so that root cause analysis of the quality defect is identified.
- To perform the root cause of the quality defect and to launch corrective and preventive actions (CAPA), the company has to make sure that all the investigation shall be performed as per the SOP of the license holder.
- Impact assessments have to be performed on all other batches of the product concerned and assessment shall be extended to other batches of the product(s) where applicable.
- On analysis If found that the cause of the recall is a quality issue that is associated with any of the raw materials used in the manufacturing, such material has to be traced and shall be established in all the product/batches subsequently produced.
- Through analysis of manufacturing records identify all the batches/products where the raw material in question was used.
- All the records from the production department have to be thoroughly inspected.
- Trace down the same raw material in question used in other formulations.
- List out every material used along with their batch number and their quantities used.
- All the other product materials that were used in the manufacturing process shall be considered for reconciliation.
- On completion of the investigation, the QA Head / authorized representative in compliance with the regulation shall provide direction on appropriate methods for disposal of recalled goods to the Distributor / Marketing Company.

Mock Recall

Mock recall shall be performed for a minimum of one batch out of any product already dispatched for sale, where the supply chain has the involvement of many distributors, to test the effectiveness of the recall alert and evaluating strategy. The efficiency of the recall procedures performed can be assessed by evaluating a true recall. During traceability of mock recall, one among the raw materials used in the manufacturing of batches identified for mock recall shall be performed. Mock Recall should be carried out at least once on the longest distribution network and whenever there is a change in the distributor/marketing company.

All the records of mock recall shall be maintained by the QA Head of the company

Table1. Comparison of recall regulations in India, USA AND EU (10, 11)

Factors	India	USA	EU
Regulatory Body	Central Drugs Standard Control Organization (CDSCO)	United States Food and Drugs Administration (USFDA)	European Medicines Agency (EMA)
Guidance	Guidelines on recall and rapid alert system for drugs (Including Biologicals & Vaccines)	21CFR Part 7, Subparts A and C - Recalls - General guidelines	European Communities Act 1972 and transpose Directive 2001/95/EC
Definition	Recall is an action taken to withdraw/remove the drugs from distribution or use including corrective action for which deficiencies are reported in quality, efficacy or safety.	Recalls are actions taken by a firm to remove a product from the market. Recalls may be conducted on a firm's own initiative, by FDA request, or by FDA order under statutory authority.	A product recall is a request to return to the maker a batch or an entire production run of a product, usually due to the discovery of safety issues.
Classification	Class I Class II Class III	Class I Class II Class III	Class I Class II Class III Class IV
Classification criteria	Risk assessment	Risk assessment	Guidance rules
Types	Voluntary Statuary	Voluntary, FDA requested or FDA mandated recall	Voluntary or at the request of the competent authorities in accordance with Article 8(1)(f)
Recall Initiation	Licensee/authorized person	Manufacturer/ Head of QA	Licensee/authorized person/ Head of QA
Communication	using the fastest mode of communication which may include email, telephone, fax, SMS etc.	Telephones, Telegrams, and Mailgrams, First classes letter approved by FDA.	Field safety notice approved by MHRA as per format within 48 hours of field safety corrective action agreement by Telephones, Telegrams and fax.

7. Conclusion

Recalling can be carried out smoothly if the management of the company follows the guidelines and

performs all the recall activities as defined. As the number of recalls increases each year significantly affecting public health, the regulatory authorities and pharmacovigilance should closely monitor pharmaceutical firms to reduce the number of recalls. Regulatory authorities should also monitor the proper disposal of the recalled product to protect the environment and human health. Every pharmaceutical company conducts mock recalls to ensure the effectiveness of recall arrangements and conducts internal inspections, audits to identify any errors/mistakes during the manufacturing process. CDSCO has implemented recall guidelines at the same level as other countries, but it should still be made mandatory that recalls be undertaken in consultation with CDSCO and without the formal approval of the recall strategy that should not be undertaken. Upon termination of the recall process, although the licensee shall submit an investigation report with details of the disposal action taken and CDSCO may state cause or legal action as required.

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Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this article.

References

1. GUIDELINES ON RECALL AND RAPID ALERT SYSTEM FOR DRUGS (Including Biologicals & Vaccines) [Internet]. Cdsco.gov.in; 2020 [cited 2020 Jul 08]. Available from: https://cdsco.gov.in/opencms/export/sites/CDSCO_WEB/Pdf-documents/biologicals/4GuidelineRecalRapidAlert.pdf
2. Sadhna D, Nagaich U. Drug recall: An incubus for pharmaceutical companies and most serious drug recall of history. International Journal of Pharmaceutical Investigation [Internet]. 2015 [cited 2020 Jul 08]; 5(1):13. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4286830/
3. Shewale S, Chavan M, Parekh S. Pharmaceutical Product Recall: Lesson Learned. INTERNATIONAL PHARMACEUTICAL INDUSTRY [Internet]. 2014 [cited 2020 Jul 08]; 6(1):5. Available from: http://ipimediaworld.com/wp-content/uploads/2014/03/Pharmaceutical-product%E2%80%A6pdf.pdf
4. Eissa M. Drug Recall Monitoring and Trend Analysis: A Multidimensional Study. Global Journal on Quality and Safety in Healthcare [Internet]. 2020 [cited 2020 Jul 08]; 2(2):1. Available from: https://meridian.allenpress.com/innovationsjournals-JQSH/article/2/2/34/434833/Drug-Recall-Monitoring-and-Trend-Analysis-A
5. DerSarkissian C. Drug Recalls: Why They Happen and What You Should Do [Internet]. WebMD; 2020 [cited 2020 Jul 08]. Available from: https://www.webmd.com/a-to-z-guides/what-is-a-drug-recall#1
6. Llamas M. Drug Recall Guide | What to Do If Your Drug Is Recalled [Internet]. Drugwatch.com; 2020 [cited 2020 Jul 08]. Available from: https://www.drugwatch.com/health/what-to-do-if-your-drug-is-recalled/
7. Choudhary A. Product Recall Procedure in Pharmaceuticals [Internet]. pharmaguideline.com; 2018 [cited 2020 Jul 08]. Available from: https://www.pharmaguideline.com/2011/08/product-recall-procedure.html#gsc.tab=0
8. Venkatesh P, Bigoniya D, Pramod T. Pharmaceutical Product Recall Procedures in India, South Africa and China. International Journal of Pharmaceutical Sciences Review and Research [Internet]. 2017 [cited 2020 Jul 13]; 46(2). Available from: http://globalresearchonline.net/journalcontents/v46-2/18.pdf
9. Pasumarthy NVG, Pichukala A, Lakshmi T, Nagabhushanam MV, Reddy DN. Contingent analysis and evaluation of pharmaceutical product recall procedure of USA and India. World J Pharm Sci. 2014; 2(12): 1728-35.
10. Goguen D. Difference Between FDA Class I, II, and III Recalls [Internet]. alllaw.com; 2020 [cited 2020 Jul 13]. Available from: https://www.alllaw.com/articles/nolo/personal-injury/fda-class-i-ii-iii-recalls.html
11. Dharmesh B, Venkatesh M, Pramod T. Pharmaceutical Product Recall in USA and EU: Comparative analysis. International Journal of Pharmaceutical and Clinical Research 2018 [Internet]. Impactfacor; 2018 [cited 2020 Jul 13]; 10(4). Available from: http://impactfactor.org/PDF/IJPCR/10/IJPCR,Vol10,Issue4,Article4.pdf